

Assessment of Smart City Approach: Its Tools and Components

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ABSTRACT

Cities nowadays especially those “non-smart” are facing challenges such as: effects of climate change, increasing in population versus resource depletion, transport problems and changing in lifestyle of people, while in the paradigm of smart city the urban area is capable to cope with most of these challenges. Despite the term of smart city is inconstant terminology and until now has not been specifically defined, in other words, there is no standard definition of this term, but now we could say that the smart city is a developed urban area that produces a sustainable economic development and creates an optimal place for people to live by increasing the quality of life through high enhancement of the both components of the city (soft components and hard components) with multiple key areas; governance, economy, people, environment, , mobility and built environment. This research explained some of the prominent variables facing most cities in world, in term of challenges of the natural environment, built environment, mobility and socio-economic features that slow down the wheel of development toward achieving a better life for inhabitants. Much of these problems and challenges can be solved by draw up a policy to develop the city based on principles of major world’s smart cities. This research also developed a scientific approach to explain smart city concept, clarified the benefits of applying this model of cities, also suggested a new “array” of the dominant components of smart cities and which of those components are recommended and implemented in four ranked smarter cities in the world.

Keywords: Smart City, Hard Components, Soft Components.

ÖZ

Günümüzde akıllı olmayan şehirler için özellikle iklim değişiklikleri, nüfus artması sonucu kaynakların tükenmesi, ulaşım sorunları ve insanların değişen yaşam tarzı gibi zorluklarla karşı karşıya iken, çoğu akıllı şehirler bu zorluklarla mücadele edebilir. Akıllı şehir teriminin tanımı tutarsız bir terminoloji olmasına rağmen, başka bir deyişle şimdiye kadar özellikle bu terimin standart bir tanımı yoktu. Ama şimdilerde biz akıllı şehir için sürdürülebilir ve ekonomik olarak üreten, gelişmiş bir kentsel alan olduğunu söylebiliriz. Bunlar şehirlerin yönetim, ekonomi, insanlar, çevre, mobilite ve yapı çevre ve kalkınma gibi birçok kolay ve zor unsurları birleştirerek şehirdeki insanların yaşam kalitesini artırarak insanlar için uygun yaşam alanları oluşturur. Bu araştırma şehirlerin doğal çevre, yapısal çevre, mobilite, yaşam kalitesi, sosyo-ekonomik özellikleri gibi karşı karşıya oldukları bazı sorunları ve zorlukları açıkladı. Bu sorunlar ve zorluklar akıllı şehir ilkelerine dayalı politika geliştirilerek çözülebilir. Aynı zamanda, bu araştırma akıllı şehir kavramını açıklamak için bilimsel bir yaklaşım geliştirdi. Çoğu şehirlerde bu model uygulanarak faydalarına açıklık getirildi. Hemde akıllı şehirlerin ana bileşenleri ile ilgili yeni bir dizi önerilerde bulunuldu. Bu bileşenler dünyanın dört akıllı şehrine tavsiye edilmekte ve uygulanmaktadır.

Anahtar Kelimeler: Akıllı Şehir, Sert Bileşenleri, Yumuşak Bileşenleri.

To all those who wish me the goodness, I dedicate this effort.

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Chapter 1

INTRODUCTION

1.1 Background

Cities in future will be the place of humankind; in the 18th century less than 5% of population was living in the cities while the vast population was living in farms for obtaining food. But nowadays about 50% lives in the city and there is likelihood to reach population more than 80% in the last of 21st century (UNPD, 2007).

By 2050, more than 6 Billion people will live in urban areas (Global Health Observatory). Growth of population makes the cities over the world to face challenges of global climate change, power sources, traffic congestions, public health and socio-economic issues.

Cities contribute to climate change and in turn are influenced by its consequences, so to resolve these challenges, the consumers should focus on the solutions driven by technology; and the need for smart solutions is growing to achieve the sufficiency in sustainable energy, fresh and drinkable water, transport efficiency and resources management. This requires re- thinking - we have to think smart to identify the challenges, and asking relevant questions, and choose the best tools.

This research will explain some of the prominent variables facing most cities in world, in term of challenges of the natural environment, built environment, mobility and socio-economic features, which slow down the wheel of development toward

achieving better life for inhabitants. Much of these problems and challenges can be solved by draw up a policy to develop the city based on principles of major world's smart cities.

Smarter cities have an opportunity to solve these distinguished challenges. They provide an eco-friendly approach to climate change and create process with an efficient resource management. Smart concept increases the quality of life of its inhabitants.

Recently, most of the researchers and IT companies proposed the idea of smart cities while focusing on certain problems in the city and giving smart solutions to those problems for example, smart grids, smart meters, smart healthcare, smart traffic management system, smart energy, and smart buildings. But in this research the aim will be to develop a scientific framework to explain smart city concept and its tools, benefits and components.

1.2 Research Problem

The term of a (smart city) is very fashionable nowadays especially in media and means many different aspects among people in different contexts. Some experts used this term as a portrayal of advanced greenly and sustainable city, while others used it in description of city that uses extensively information and communications technology in all its parts and processes.

The term of smart city is inconstant terminology and until now there is no specific definition of this term, in other words, there is no standard definition of “smart city” because this term is used in different context and aspects. However, most scholars

and specialists haven't reached to unified definition of the smart city; as well there is no clear idea about the advantages of this kind of city and what might be offered to our cities. Until now the components and indicators of smart city are not standard, still unclear, inconstant and variable due to the point of view of specialists.

1.3 Research Aim and Objectives

This research aims to develop a scientific approach to explain smart city concept, to explore the benefits of applying this model of cities, also to shed light on the dominant features in soft and hard components of smart cities and which of those significant components are recommended and implemented in virtual paradigms in the world.

1.4 Research Methodology

To achieve the aim of research, the author will depend on the literature review to detect the current definitions that are suggested by many scholars to develop the definition of smart city and to clarify the goals and benefits of smart cities. Also the author will analyze selecting international case studies of first four ranked smarter cities in world to understand the common features that have been considered among those cities, as well to specify the outstanding features that have been considered in each city.

1.5 Thesis Outline

- **Chapter 1:** Introduction; background, research problem, research objective and research methodology.

- **Chapter 2:** Literature Review; this chapter aims to review the existing studies around smart cities, and to create a theoretical foundation for the current studies.

- **Chapter 3:** Understanding The Smart City; This chapter aims to define the smart city with the reasons that encourage applying this brand of cities, explain the goals and benefits of Smart Cities, as well to elaborate the components of smart city among many aspects and develop new framework to match and grouping those components

- **Chapter 4:** International Case Studies on Smart Cities: In this chapter the author will shed light on the process of building a smart city by selecting international case studies of first four ranked smarter cities in world to understand the common features that have been considered among those cities, as well to specify the outstanding features that have been considered in each city.

- **Chapter 5:** Conclusions and Recommendations

Chapter 2

LITERATURE REVIEW

2.1 Introduction

The idea of the 'Smart City' is rather fashionable in the policy context and most recent studies related in the cities and urbanism. It seems the primary focus in most studies and researches is on the role of ICT (Information and Communication Technology) in the city, although a lot of dimensions play a crucial role in the city. These dimension are attached with the Economy, People, Governance, Mobility, Environment and Living (Giffinger, 2007).

2.2 Smart City's Relatives

Here are some “ brands” of city like Digital City, Intelligent City, Ubiquitous City, Creative City, Knowledge city and Learning City, which would be similar to smart city in its domains and involved in the six dimensions of the smart city, which are Economy ,People, Governance, Mobility , Environment and Living (Giffinger,2007).

2.2.1 Digital City

Domain: Technology of information in community.

Digital City refers to the linked community which associates telecommunications infrastructure broadband, and soft computing infrastructure, its services based on open industry standards and advanced facilities to meet the needs of the government with its employees and the people. The main target of digital city is to create environment for the exchange of information, cooperation and experience for the whole inhabitants in all places (Yovanof and Hazapis, 2009).

Also the term ‘‘Digital City’’ refers to a set of virtual practices carried out in a sustainable manner by residents and groups in the city for the interaction, simulation, explaining, reinforcement, monitoring and achieving the communication of the daily activities in the community. So the digital city is a model of virtual interface where the modern city on some aspects of traditional and social interaction daily activities are carried out outside and converted accordingly (Michel, 2005).

2.2.2 Intelligent City

Domain: Technology of information in built environment.

Intelligent City is the city that has all infrastructures of information technology and communications (Besselaar and Koizumi, 2005). The abundant action in the scope of innovation is a distinctive trait of intelligent because by intelligent all new problems are being solved, so it considers the main feature of the intelligence (Komninos, N. 2002). Intelligent City focuses on the development of urbanization, city growth and demands of urban residents. Intelligent City requires effective integration of advanced information technology with advanced operating and service philosophy (Insigma, 2012).

Intelligent City collects and stores numerous information sources in real time to create the information technology infrastructure, Exchange and sharing data by collaborative applications, it will create a platform that provides a comfortable, efficient, and flexible tool for the generation and implementation of resolutions concerning the city management and operation, as well as for the provision and management of public services, with the ultimate goal of achieving harmonious

development for safer, greener ,more efficient and convenient urban place (Insigma, 2012).

2.2.3 Ubiquitous City

Domain: Technology of information in community.

The city everywhere or U-City is the concept of ubiquitous computing integration into the urban environment. It can be described as integrating information systems and social systems, which is linked to almost every device and network service information through wireless networking and RFID tags and sensors. Ubiquitous City is an extension of Digital City has the same concept in term of access to every place (Anthopoulos et al, 2010). It makes abundant computing devices existing to all parts of city such as buildings, roads, bridges and landscapes. It aims to build a city where any inhabitant can obtain any services at any place and at any time by these devices (Lee, 2008).

2.2.4 Creative City

Domain: People, Economy, Built Environment.

Creative City was an idea developed by urbanist Charles Landry in the late 1980s and become a global movement producing the new model of urban planning. The creative city considered as creative ambition where encourages the openness and imagination , which means a significant impact on organizational culture .It assumes that the need to create conditions for people to think and plan to work with imagination in connecting opportunities for addressing urban problems that seem inflexible. These ranges may address homelessness; to create wealth or improve the visual environment. Assumption that ordinary people can make extraordinary happens if given the opportunity.

Creativity is applied imagination, in the city there are not only creative artists and workers in the creative economy , even though they play an important role, but the creativity can come from any source, including any person who deals with issues in an innovative way, whether a social worker , a businessman, a scientist or a public official (Landry, 2000).

2.2.5 Knowledge City

Domain: People.

Edvinsson (2006) defined a knowledge city as "the city designed intentionally to encourage nutrition knowledge". This city distinguishes in many properties and aims to make knowledge accessible to citizens, by establishment of network for public libraries and connect them with all libraries in the world which requires provision of the communication technologies to all citizens, with all cultural facilities and services and educational tools. The knowledge city has a network of schools with technical teachings throughout its region, and simplifies the collective and civil associations through the provision of e and knowledge resources and cultural activity. A knowledge city with urban centers is open to diversity and promotion the relationships that are face to face and allows citizens of other lands to express themselves.

2.2.6 Learning City

Domain: People.

Cities are not just places where people live and work: they are also the places that achieve for people the entertainment, culture, and education. A learning city provides all variety of learning tools to meet the needs and ambitions of its citizens. Through a combination of local resources they bring together, learning cities providing local solutions to local challenges Learning city means learning society where all

resources and tools available and strive to develop the human capital to enhance personal growth, maintaining social solidity, and the making of wealth. This idea is similar in the end to the Knowledge City (Longworth, 1999).

2.3 Smart City Notion

Smart city as notion appeared in different meaning over the world cities when some of them (e.g. Singapore, Amsterdam, Stockholm, etc.) adopted ICT (Information and Communication Technology) in their utilities and applied it in all city parts e.g. the transportation, water and electricity management , car parks, etc. to integrate each part with the others (Del Bo and Florio, 2008).

Smart city notion has been derived from different definitions, especially those cities which have intelligence and hi-tech in their content (e.g. City of Knowledge, Digital City and Information City). These different “brands” are similar to the idea of the smart city and have several distinctive characteristics and different components; however, the different definitions are varied in the scope and concentration (Hollands, 2008).

The notion of smart city is itself ambiguous and often changeable and launched from the perspective of technology that ICT represents the driving force in the transferring of innovative internet services (Chourabi, Nam, Walker, Gil-García, Mellouli, Nahon, Pardo and Scholl, 2012). “Information City” is to collect data from providers and deliver it to the people via Internet. While “Digital City” is a connected community that shares broadband communications services to meet the needs of government and its employers and citizens (Yovanof and Hazapis, 2009).

Many researchers have also asserted on the importance of city networking organizations, which contain various participants including government, corporations and social groups. Arguments on the digital city have focused mainly on development of internet services for different groups, which provides services to city components and citizen.

Digital City and Information City are the city of ubiquity; i.e. “city in every place”, which makes data available through embedded urban infrastructure through implement the ICT equipment in all city parts such as roads, bridges and buildings. The notion of smart city also derived from the government of South Korea which utilized ICT in the city-run network to provide its citizens with services (Lee and Phaal, 2013).

The aim of this city is to apply information and technology infrastructure in all forms of urban spaces with and the provision of various services including those involve in energy and environmental monitoring (Lee and Phaal, 2013).

Lee, Han, Leem, and Yigitcanlar (2008) emphasized on the idea of U – city as a city of connection services because it works within the urban space. It will support these efficient services of the city and the quality of life for its citizen regardless of time and place. However, this concept puts less importance on users made of the social infrastructure for instance a human and the perspective of social capital.

Smart cities lead to a vital change in the nature of life and work in the city, instead of merely additional space for improvements. Endoscopy of smart cities is usually

placed in the context of ' Knowledge economy ' which considers human thinking and Social capital as the most valuable resources (Yigitcanlar, Velibeyoglu, and Martinez-Fernandez, 2008).

Development (Including social development) seeks to take advantage of these resources in the ability to support the creation of knowledge and procedures to education. Technological innovation is the core of smart city that places of any concept ' City of Knowledge ' in order to promotes knowledge. It is demonstrated that this concept of smart city derived from different perspectives, including the "Information City", this concept; however, has gradually evolved the idea of the city -centric information and communications technology or an open city (Nam and Pardo, 2011).

2.3.1 Smart City in Scholars Perspective

Murray, Minevich, and Abdoullaev (2011), emphasized on the relation between the components of the city and the culture, for achieving the maximum benefit from the Smart City; the variety of population is the main factor to increase cooperation and exchange of knowledge among citizens.

Murray, Manevich, and Abdullayev (2011) also stated that the shortage of finance is most important problem that confronts the smart cities; despite the fact that there are many studies argued that investment in human capital development contributes to economic growth. Additionally, the authors clarified that the smart city becomes likely to fail if any technical error occurred in the main systems of the city.

Hollands (2008) evaluated the real term of the smart city, and mentioned it as a phenomenon in the urban context. He argued that the meaning is not accurate and

self-congratulatory and contains silent expectations. Also he raised the question whether the developed economy and sustainable environment are suitable, and enhanced an important evaluation of the urban growth from an economist's perspective and asserted on the "*utilization of networked infrastructure to improve economic and political efficiency and enable social, cultural and urban development*", where the term "infrastructure" indicates to commercial services, leisure, housing and all technology services. The notion fetches to the head the idea of a wired city as the key progress model and of connectivity as the basis of growing.

Beck (2011) evaluated the smart city according to the basic principles of the digital city which bring enormous to the city, but these changes and advantages are not able to reach everyone in the city because the diversity between people in in term of social level and education background. In addition, he pointed out that especially in the context of the transport the smart city may cause undesirable effects on the environment when using the traditional fuel chemical resources, but these adverse effects would be solved by continuous technological improvements.

Clancy (2013) noted that many smart city projects have ignored the need to involve citizens and the role of the public in the enterprise procedure, which leads to unsuccessful implantation of these projects.

2.3.2 Smart City and the Role of People

Glaeser and Perry (2006) showed that the most rapid urban development happened in the cities that have high numbers of educated people and workforce. Also they mentioned that the availability of the information and communication technology is not only the indicator of smartness of the city. Different experiences emphasized the role of human and education as obvious evidence of smart city.

Perry and Glaeser (2006) clarified the model of the relationship between human and urban development arguing that invention is led by entrepreneurs in commerce and production requires increase the workforce. Not all cities with equal success in investment of human capital, studies recognized that cities are diverging in terms of human capital and educated workforce.

2.3.3 Smart City in Context of Providers

The major and famous technology provider companies such IBM , Siemens and Sisco played an important role on shaping smart cities through encouraging the cities on inserting the technology in their infrastructure to achieve many benefits of sustainable development , for example, the efficiency in water consumption and reducing carbon emission are results of enhancing the public utilities by technology.

IBM (2010) described a city as a (system of systems) and emphasized on the role of ICT in sharing the information and communications among the city components and how the ICT can enable the planners and policy-makers understand these systems and how to facilitate services to residents.

2.3.4 Smart Cities in Context of Champions

Especially The European Union (EU) committed to lasting efforts for formulating meaning of smart urban development for its cities. The European Union, as well as other International organizations and research organizations emphasized on the ICT infrastructure role in the cities development. EU adopted The Smart Cities Project which is an innovative cooperative project between thirteen partners from six European Union countries, the goal of the project is to create an innovation network between members, in order to develop and provide improved services for citizens and businesses with a focus on sustainability (The European Commission, 2012).

Chapter 3

UNDERSTANDING THE SMART CITY

3.1 Introduction

This chapter aims to define the smart city with the reasons that encourage applying this brand of cities, also explain the goals and benefits of Smart Cities, as well develop a new framework for the components of smart city in all its dimensions that are confirmed by researchers and specialists.

3.2 Defining the Smart City

The term of a (smart city) is very fashionable nowadays and means many different aspects among people in different contexts, some experts use this term as a portrayal of advanced green and sustainable city, while others use it in description of city that uses extensively information and communications technology in both hard part (infrastructures) and soft part (society). It is a new style of city that provides sustainable and smart growth while enhancing the quality of life (QoL) by reducing the burden effects on environment as CO₂ emission that would contribute to build economic and healthy environment to residents.

The root of this term derived from the (Smart Growth Movement) in the late 1990s. Although a wide range of using the term of (smart city), there is unclear understanding of the substantial concept among academics and practitioners.

Some scholars worked to define this term, as followings:

- 1- “A Smart City is a well performing city built on the ‘smart ‘combination of endowments and activities of self-decisive, independent and aware citizens.”Giffinger, et.al (2007: 11).

- 2- “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”.Caragliu,et.al (2011:70)

The term of smart city is inconsistent terminology and until now has not been specifically defined, in other words, there is no standard definition of “smart city” whereas this term is used in different context. Many organizations created their own indexes of the criteria for determining whether the city is a smart or not.

After exploring among different studies we can define the smart city as:

A developed urban area that produces a sustainable economic development and creates an optimal place for people to live by increasing the quality of life, through highly enhancement of multiple key areas; governance, economy, people, environment, mobility and built environment. Enhancement of these key areas can be achieved through human capital and infrastructure for information and communication technology.

3.3 Factors behind the Demand on Smart City

Urbanization is an essential issue nowadays where the most of agricultural lands are converted to be urbanized and at the same time increasing population means increasing the need to infrastructure including the electricity, water, transportation, communication and all other services. All of these services need to be provided to the residents in short period of time with effective ways to make the life of people easy and livable.

In conventional cities such infrastructures no longer meet the modern-day lifestyle of residents. Thus, revision of the form of city became an urgent need to meet the essential requirements of people. In addition to that the developing nations are facing critical social issues such as reducing the birth-rates, completely aged society and decline of tax revenues. Proceeding the old methods for improving the quality of life (QoL) of residents and solving the problems that face the cities are not suitable costly and functionally.

Applications of technology and advanced communication methods will achieve smart cities capable to solve most problems. This type of cities doesn't mean just a changing in outer form of city but means achieving the innovation in lifestyle of people themselves. Smart city is not just a duty of government and companies, the people should be actively involved in sharing their ideas and opinions to formulate this type of cities. Smart city maximizes the benefits to the city inhabitants by reducing the negative effects on the economy and environment. The demand on this type of cities is increasing continuously in both developed and developing countries to achieve a new lifestyle which can be provided by the smart city (Hitachi, 2009).

The reasons encourage applying the smart city are:

3.3.1 Confronting the Global Challenges on the Environment

Smart city handle the undesired changes in environment resulted of uncontrolled urbanization, these adverse changes are:

Climate Change and Global Warming

Governments, researchers, and companies started to focus in much consideration on the reasons and the effects of global warming and climate changes. It is clear that the impact of climate change leads to major risks for all communities. These risks include secondary damage, such the impact of harmful weather and natural disaster on the economic development.

Changes in the global climate warming are closely associated with the emission of gases such as carbon dioxide, and methane, which often produced from industrial activities. To reduce and mitigate the global warming, many governments and private groups working on processes to reduce global warming Greenhouse gas emissions. These procedures include steps towards the creation of new general framework for Emission reductions.

Resources Reduction versus Population Growth

Economic progress and high population density increase the consumption of resources which, in turn, cause the reduction of resources and increases in the prices of limited resources. This problem increases in parallel to the increase in population. According to "United Nations Fund for population," the world Population increased 2.8 times in 1950 (2.5 Billion People) to 2011 (7 Billion people). Population is expected to reach 9.3 Billion in 2050.

The Negative Effects of Urbanization

Urbanization is growing rapidly. The United Nations predicts that in 2020 the urban population will exceed the rural population; in 2050 about 70% of the world's population will live in cities (Figure 1). In turn when the urbanization increases; the negative effects increases as well and many problems will appear in urban areas. The problems include poor neighborhoods, air pollution, lack of water and lack of energy, traffic congestion, insufficient ability to Sewage treatment and inadequate the ability to get rid of urban and industrial waste (WUP, 2012).

In addition developed economies are confronting new problems such as the need to make cities more compatible with less births and an aging population also the need to provide mobility options for older residents (Hitachi, 2009).

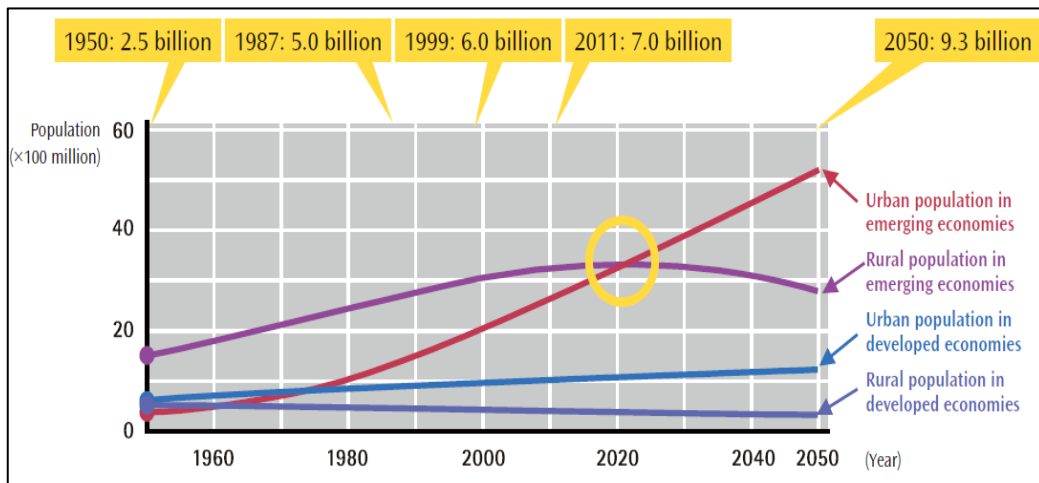


Figure 1: Trends in urban and rural populations
Source: World Urbanization Prospects, The 2011 Revision, United Nations

3.3.2 The Need for Changing Lifestyles

Smart Cities are also required to deal with the ongoing changes in the values of life for residents. This section describes some relevant aspects:

Usage before the Ownership

Remarkable trend nowadays is the increase of the sharing and hiring the properties that enable people to achieve the benefits of ownership without the disadvantages. A distinctive example is the increase in the exchange or renting cars, which allows users to use vehicle whenever and wherever one is required. The ownership of material products brings with it the need for maintenance, while the exchange or rental of properties can be free for people.

Concentrating On Non-Monetary Values

People's way of thinking in the payment for services also changed, in some cases, exchange services for non-cash revenues (including Satisfaction of helping others). For example, a growing number of people in the use of Internet search for persons or places where their skills necessary, but recipients don't have the ability to pay market rates for the service providers. Smart cities provide markets in which the funds can be used and the exchange of value, but it should also provide mechanisms and infrastructure to allow other complex and various forms of value exchange occur smoothly.

3.3.3 Problems in the Core of City

These problems include: Transport and Water problems.

Transport Problems

The most significant transport problems often occur in city centers, and happen when the transport systems cannot meet the mobility requirements. In cities, productivity is

highly reliant on the efficiency of the transportation system for transporting workers, individuals and convey of goods between numerous places and destinations. Furthermore, there are important transportation pivots such as ports and airports within urban areas, which also add other problems. Some of the problems are old, such as congestion, while others are new, such as the environmental effects. Among the most noticeable urban transport problems are:

- **Traffic Congestion and Parking Troubles:** Congestion is one of the most dominant problems of transportation in large urban areas. It is associated with the spread of motorized transport and utilization of private cars, which led to increasing demand for transport infrastructure. However, the provision of infrastructure is often not able to keep up with traffic growth. Congestion and parking is related with looking for parking and creates additional delays and weakens the local traffic circulation. In the central areas of large cities drivers may spend 20 minutes looking for a parking place.
- **Longer Traveling:** People are spending a lot of time in the transition between the place of residence and place of work. An important factor behind this trend related to the affordability of existing housing units away from central areas (where most of the housing) is more affordable.
- **Inadequate Public Transportation:** Many public transport systems, creates inconvenience for users during peak hours, and don't meet the demand. Decrease in the number of passengers makes many services that are not financially sustainable, especially in suburban areas, so public transport

systems cannot generate sufficient income to cover its operating costs and capital.

- **Environmental Impact and Energy Consumption:** Pollution including noise is generated by the rotation and causes serious problems to the quality of life and health of urban residents. Also, energy consumption by urban transport like oil has another form of pollution.
- **Accidents and Safety:** It is associated with increased traffic in urban areas with the increasing number of accidents and fatalities, particularly in developing countries. Accidents account for a large share of the repeated delays. With the increase in traffic, people feel less safe to use in the streets. (Jean-Paul Rodrigue, 2013).

Problems with Water

Water is a vital service to urban life, but most cities have problems with water-use efficiency, leakage and quality which can be considered as a crucial challenge for local governments. Water system is sensitive to the development of economic and demographic cities. Increase in the number of the population creates a growing demand for water. Today, cities consume 60% of all water intended for human use. The leakage is one of the problems of water system, which reaches up to 60% of available water, and the cost reaches up of 14 Billion USD annually in the all over the world (NRW, 2006).

Globally, water shortage affects economic growth and creates pressure on food prices. The growing number of the population and economic development for the citizens effects of water use. (Arjen, Ashok, Chapagain, 2011).

3.4 Goals and Benefits of Smart Cities

New technology offers the best ways to measure important performance indicators that really concern citizens. This technology allows city to move towards the model of smart city model which puts the citizen at the center of Services. Smartest cities are offering a range of solutions in urban areas such as transportation, public safety, energy, utilities, education, health care and others. The main objective of this idea is to help cities to understand and meet these demands (Forrester Research, 2010). These services tend to make performance of city more efficient and citizen life easier, some of benefits of living in smart city are listed following:

People Life, Environment and Economy

Smart city increases efficiency and makes a positive environmental effect, improves security, improves health, these results make the city more livable and attractive, vital economy and attractive for citizens and social activities. Smart City can meet the potentials of the highest sustainability for environment, community and economy.

Smart city aims to efficient use of energy to reduce costs and improve the environment by either directly way through less pollution or indirectly by reducing greenhouse gas emissions.

Cities, especially in Europe have set “European Commission” 20-20-20 agenda³ green, which planned to a long-term strategy to overcome climate change, and to

develop common goals to lower greenhouse gas emissions and sharing knowledge with each other (http://ec.europa.eu/clima/policies/package/index_en.htm).

Transport

Transport and traffic are real problem in cities; the solution in case of smart cities can be achieved by technological advantages on the side of the roads with sensors as well as the use of global positioning systems to improve urban traffic. One of the examples provided by IBM is Amsterdam City, where traffic congestion and carbon emission have been reduced thanks to the new smart toll system.

One of the main solutions adopted by municipalities to cope with congestion is encouragement of people to use public transportation by providing a sufficient number of buses, trains and trams. Reduce congestion means reducing the number of private cars on the road will help as well to decrease of time that people spend to get to and from their place of work.

Information about mobility situation is also important for people to be able to get real-time information on cars movement, pedestrians and cyclists to help them better understanding of the movement of people across the city (GSMA, 2013).

3.5 Features and Components of smart city

3.5.1 Giffinger's Classification, 2007

Giffinger et al. (2007) developed the definition of smart city model by using six distinctive characteristics to rank European cities. He used the classification system as a tool to evaluate the cities in the fields of economy, people, governance, mobility, environment and living (Figure 2).

<p>SMART ECONOMY (Competitiveness)</p> <ul style="list-style-type: none"> ▪ Innovative spirit ▪ Entrepreneurship ▪ Economic image & trademarks ▪ Productivity ▪ Flexibility of labour market ▪ International embeddedness ▪ <i>Ability to transform</i> 	<p>SMART PEOPLE (Social and Human Capital)</p> <ul style="list-style-type: none"> ▪ Level of qualification ▪ Affinity to life long learning ▪ Social and ethnic plurality ▪ Flexibility ▪ Creativity ▪ Cosmopolitanism/Open-mindedness ▪ Participation in public life
<p>SMART GOVERNANCE (Participation)</p> <ul style="list-style-type: none"> ▪ Participation in decision-making ▪ Public and social services ▪ Transparent governance ▪ <i>Political strategies & perspectives</i> 	<p>SMART MOBILITY (Transport and ICT)</p> <ul style="list-style-type: none"> ▪ Local accessibility ▪ (Inter-)national accessibility ▪ Availability of ICT-infrastructure ▪ Sustainable, innovative and safe transport systems
<p>SMART ENVIRONMENT (Natural resources)</p> <ul style="list-style-type: none"> ▪ Attractivity of natural conditions ▪ Pollution ▪ Environmental protection ▪ Sustainable resource management 	<p>SMART LIVING (Quality of life)</p> <ul style="list-style-type: none"> ▪ Cultural facilities ▪ Health conditions ▪ Individual safety ▪ Housing quality ▪ Education facilities ▪ Touristic attractivity ▪ Social cohesion

Figure 2: Six distinctive characteristics of smart city
Source: Giffinger et al. (2007)

3.5.2 IBM's Classification, 2009

Planning and Management, Infrastructure, and Human form the city, that was in IBM's Smarter Cities work which began in late 2008 as part of the smarter planet initiative, which (IBM, 2009):

Planning and Management: Public safety, Smarter Buildings and Urban Planning, Government and Agency Administration.

Infrastructure: Energy and water, Environment, Transportation.

Human: Social Programs, Healthcare and Education.

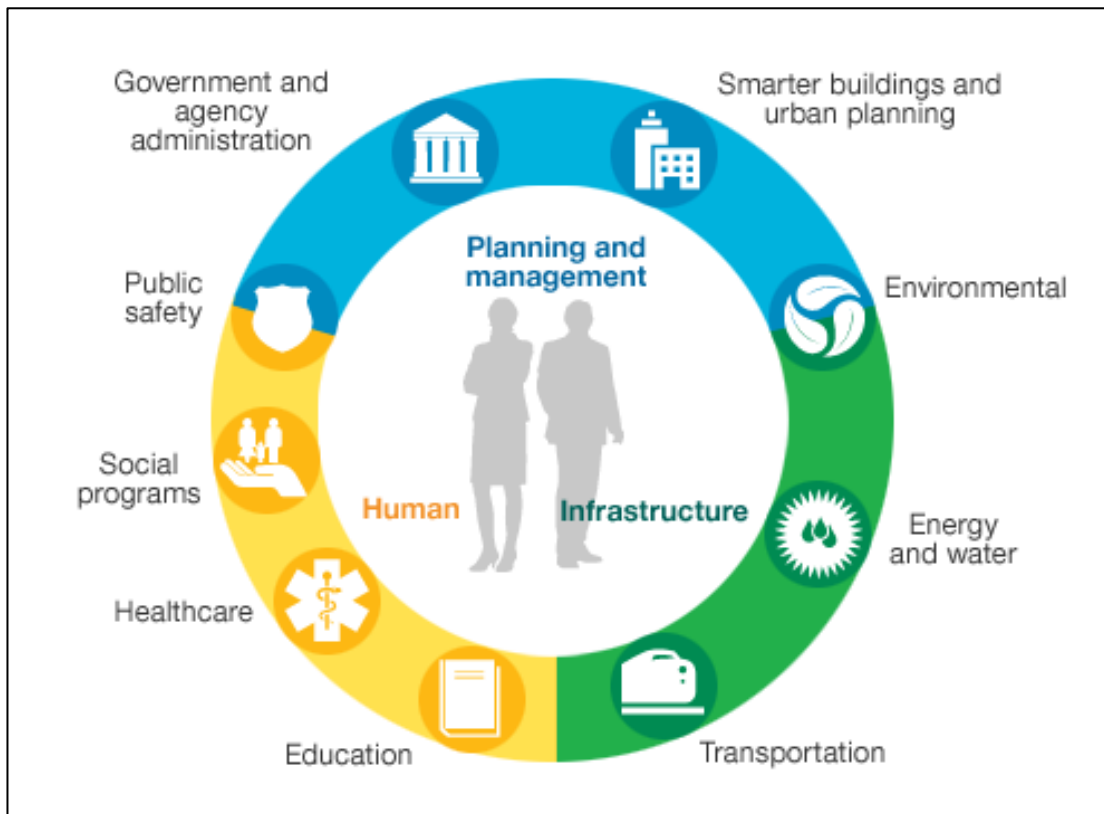


Figure 3: Components of City
Source: IBM, 2009

3.5.3 Telefónica Company's Classification, 2013

Telefónica Company which is one of the world leaders company in integrated operator sector and specialist in smart city has set in 2013 its own list of five components of smart cities as shown in (Figure 4):

Components	Features
Smart Mobility	Smart Parking, Fleet Management, Intelligent Transport System, Traffic Management, Community Biking, Electric Vehicles, Infrastructure Smart Taxi
Energy and Environment	Smart Building, Smart Grid And Smart Meters, Smart Urban Lighting, Waste Management, Watering Management, Noise Detection
City Economy	NFC Services, Digital Signage, E-Tourism, Connected Retailer
City Management	Smart City Dashboard, Smart City Operations Center, City Maintenance
Security and e-Health	Video Surveillance, Tele-Health and Tele-Care, Emergency Management

Figure 4: Smart City Components
Source: Telefónica Company, 2013

3.5.4 Meeting of the Minds' Classification, 2014

On 12 March 2014, sustainable cities conference organized “Meeting of the Minds” under title; Smart Cities: Turning Information into Action. In this conference there was a consensus to group the components of smart cities into three parts:

- **Soft Infrastructure:** The things that place the ideas and plans, these include regulations, education, laws, policies, human capital ... etc.
- **Hard Infrastructure:** Things that to be built or plan to build, these include built environment, mobility, utilities, energy, water, grids ...etc.

- **Technology:** This represents the bridge between soft infrastructure and hard infrastructure, also the means and tools to build best cities to live.

3.6 Integration of Smart City Components

Although the classification of smart city components is various but the contents and main features are rather similar, following is a schedule shows the integration of four previous classifications of smart city's components (Table 1).

Table 1: Combination of Components of Smart Cities

Source: Adopted by Author

2007 Giffinger		2009 IBM		2013 Telefónica		2014 Meeting of the Minds	
Smart Economy	<ul style="list-style-type: none"> Innovative spirit Entrepreneurship Economic image & trademarks Productivity Flexibility of labor market International embeddedness Ability to transform 	Planning and Management	<ul style="list-style-type: none"> Public safety Smarter Buildings and Urban Planning Government and Agency Administration. 	Smart Mobility	<ul style="list-style-type: none"> Smart Parking Fleet Management Intelligent Transport System Traffic Management Community Biking Electric Vehicles Infrastructure Smart Taxi 	Soft Infrastructure	<ul style="list-style-type: none"> Regulations Education Laws Policies Human capital
Smart People	<ul style="list-style-type: none"> Level of qualification Affinity to life-long learning Social and ethnic plurality Flexibility Creativity Cosmopolitanism/ Open-mindedness Participation in public life 			Energy and Environment	<ul style="list-style-type: none"> Smart Building Smart Grid and Smart Meters Smart Urban Lighting Waste Management Watering Management Noise Detection 		
Smart Governance	<ul style="list-style-type: none"> Participation in decision-making Public and social services Transparent governance Political strategies & perspectives 	Infrastructure	<ul style="list-style-type: none"> Energy and water Environment Transportation 	City Economy	<ul style="list-style-type: none"> NFC Services Digital Signage E-Tourism Connected Retailer 	Hard Infrastructure	<ul style="list-style-type: none"> Built Environment Mobility Utilities Energy Water Grids
Smart Mobility	<ul style="list-style-type: none"> Local accessibility (Inter-)national accessibility Availability of ICT-infrastructure Sustainable, innovative and safe transport systems 			City Management	<ul style="list-style-type: none"> Smart City Dashboard Smart City Operations Center City Maintenance 		
Smart Environment	<ul style="list-style-type: none"> Attractivity of natural conditions Pollution Environmental protection Sustainable resource management 	Human	<ul style="list-style-type: none"> Social Programs Healthcare Education 	Security and e-Health	<ul style="list-style-type: none"> Video Surveillance Tele-Health and Tele-Care Emergency Management 	Technology	The bridge between soft infrastructure and hard infrastructure
Smart Living	<ul style="list-style-type: none"> Cultural facilities Health conditions Individual safety Housing quality Education facilities Touristic attractivity Social cohesion 						

As appeared from (Figure 5), the classifications of (Giffinger, 2007), (IBM, 2009) and (Telefónica, 2013) are rather similar because they are involved in the same dimensions (domains) as illustrated in the following diagram:

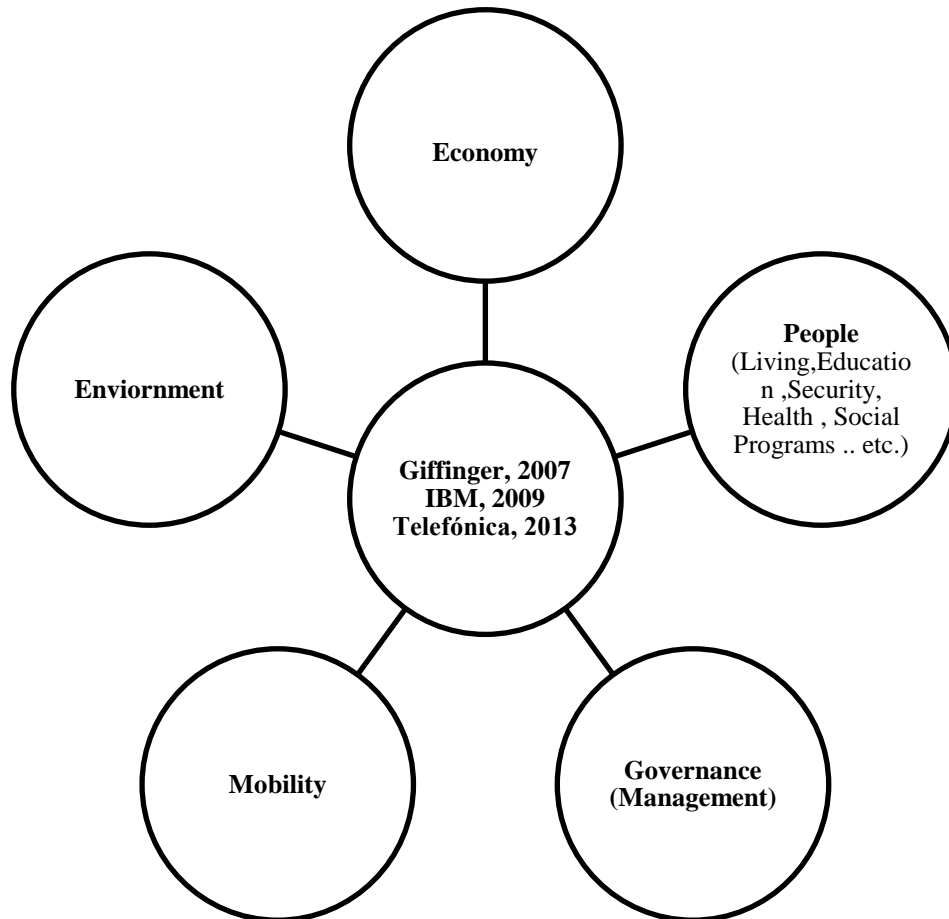


Figure 5: Combination of Components of Smart Cities
Source: Adopted by Author

According to the classification of “Meeting of the Minds” which grouped the components of smart cities into three parts (Soft Infrastructure, Hard Infrastructure and Technology), and to facilitate understanding the components of smart city, it is better to suggest a new “array” to include all components and indicators of smart city under two main themes (Soft Components and Hard Components), this suggestion is based on integration of previous studies and elimination of repeated

items, this suggestion will group components into two main themes (Soft Components and Hard Components) as appears in figures 6&7.

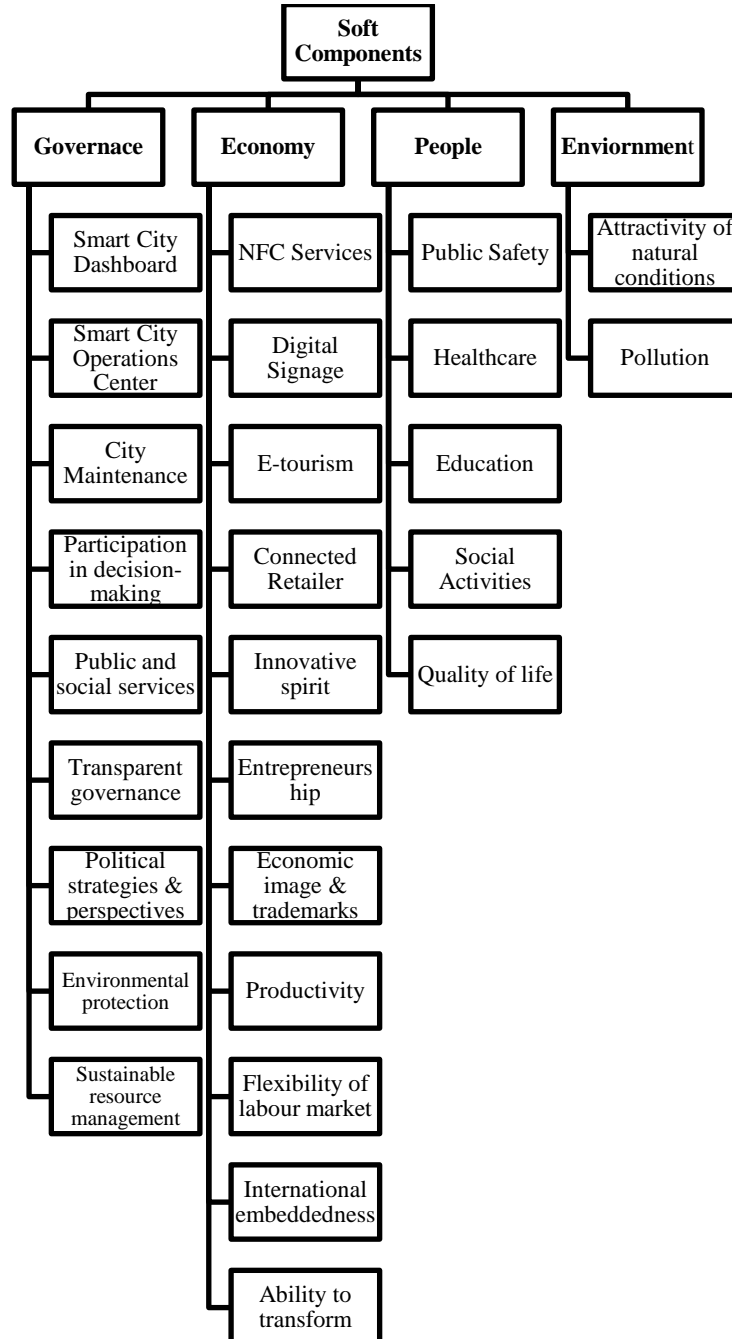


Figure 6: Soft Components of Smart City
Source: Adopted by Author

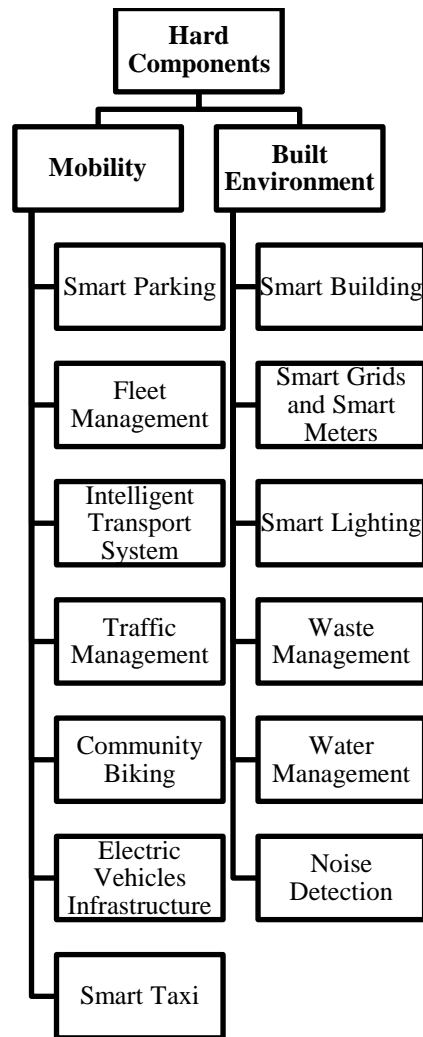


Figure 7: Hard Components of Smart City
Source: Adopted by Author

3.6.1 Soft Components of Smart Cities

As suggested by scholar, the soft components of smart city include four main themes integrated and elaborated according to four previous scholars (Giffinger, IBM, Telefónica and Meeting of the Minds) and include (Governance, Economy, People and Environment).

Governance

The World Bank defines governance which authority is implemented in the administration of the resources of the country's economic and social development

(World Bank, 1991). While the term of smart governance can be interpreted as the use of different policies, models and techniques for implementation and provide effective service to the citizens. Smart Governance focuses on improving public services and operations. Support ICT e-government services and open data sources will open new channels between non-governmental organizations and citizens. Coordination of the various public sector institutions, and makes them work cooperatively with the help of information and communication technology is a key success indicator of smart governance. Establish of an information system to coordinate between local municipalities and other organizations. This system will be prepared for operations “urban information system” and will be the establishment of national geographic information systems and physical planning portal. Information system also will contribute to provide a digital database pursuing center to support spatial planning (IBM, 2009).

This feature is important to integrate the admiration operations systems with singular systems to work as one system, the building of Smart City will work in harmony only through precise following to public standards.

Seoul created communications network services and established in 2003 Optical network management called “e- Seoul Net” includes a fiber-optic cable along the subway to link the public buildings in the city with its associated offices and municipalities. Officers can contact from affiliated offices in order to exchange data with main administration, and citizens can access to administrative services at any time and in any place. In the future, plans to take advantage U - Seoul Forum in areas

such as child safety, and emissions from vehicles control systems are able to reduce energy costs in the city.

One of the most important characteristics in smart city is (City Dashboard) which is the operations center to assist the leaders of the city in the exercise of their functions in many aspects of the administration of the city. City Dashboard links the all city parts and enhances the ability to cross over to key agencies, such as emergency management, public safety, social services, transport and water. Also this feature facilitates communication between city and citizens to understand the situation in the city and achieving more cooperation between departments. Operations Center saves cities money by reducing the number of staff needed to make decisions and allocates resources more effectively (IBM, 2009).

For example City Dashboard was launched in London in April 2012, to be the window of eight cities throughout Great Britain. It combines data, media, and social observation in one screen, panel that are constantly updated as people watch it. There are alternative views for each city vision shows map data in real time, view the version of the network more than the minimum, which shows a series of squares that change color and size based on the data they represent (Figure 8). City Dashboard includes weather data (measurements, observations and forecasts), bike-sharing station, air quality measurements, river levels, traffic cameras, the BBC local news updates and Open Street Map (<http://citydashboard.org/london/>).

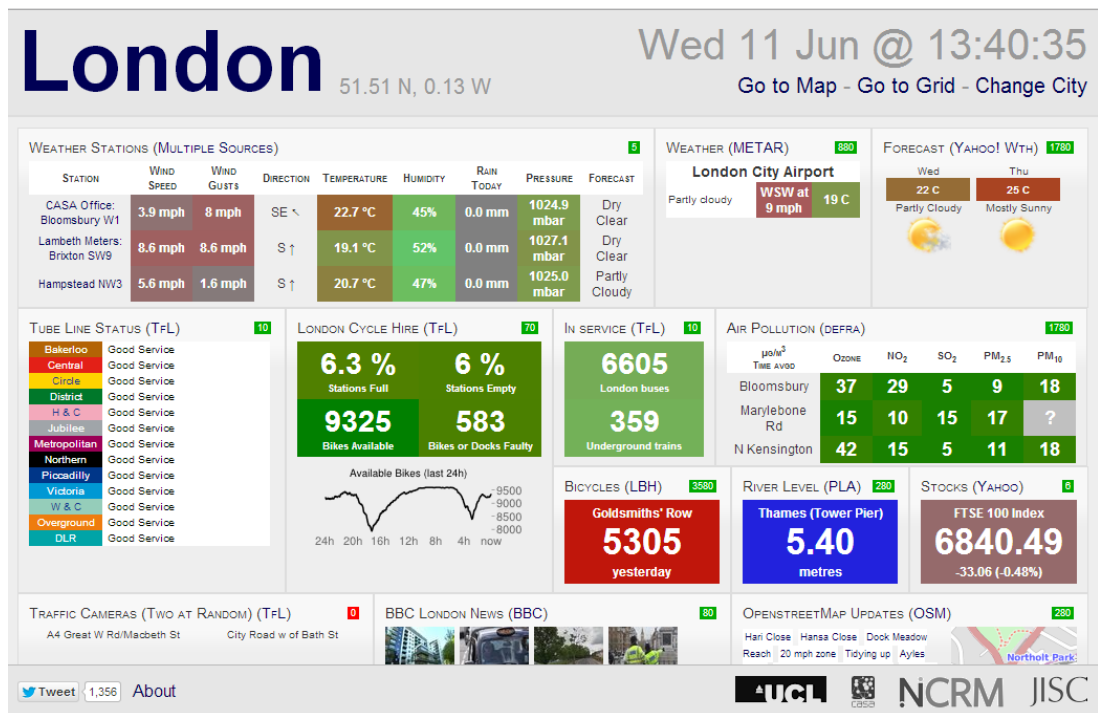


Figure 8: City Dashboard
 Source: <http://citydashboard.org/london/>

Another characteristics in smart city is City Maintenance, This feature is based on select the type of service (mechanical, plumbing or electrical) with providing the help of smart solutions to improve service efficiency and quality , this service is controlled by the use of mobile devices (Telefónica, 2013).

Economy

Economy includes all cities' business in term of regulation and policy includes planning systems, open foreign trade and investment, and market legislation of labor and the product (IBM, 2009). The common objectives of the actions taken under this distinctive feature are to reinforce the effectiveness economy and of the smart city in all domestic and international markets. These objectives would be achieved by application of many procedures to build and conserve of collective network clusters for business and cooperation with the many participants (such as universities,

companies, organizations). In order to stimulate innovation through the creation of thought, Smart City improves its economic situation. Furthermore; increase the using of internet for inhabitants and commerce to use electronic devices in commercial dealing such as e-shopping and e- banking (Tubita, 2010).

People

People represent the social infrastructure and the basic foundation for success of the smart city because the implementation of a technology infrastructure is not enough without the participation of citizens in growth process.

Social infrastructure (intellectual capital and social capital) is a nerve of smart city life and also involves with education, training, culture, arts and business (Barlett, 2005). Approach the strongest growth of consciousness among people, and provide facilities that can be accessed from each citizen, to remove fences related to language, culture, and education, progress of skills and incapacities. Public erudition calms anxiety for people are lagging because of using the technology. It should be the development of education and training on the relevant procedures IT skills, care workers in the field of knowledge (Cairney et al, 2000).

For Singapore, IT skills is required not only for business or industry but for everyday life. Ability to use computer is become a must skill for education like reading, writing and arithmetic. Singapore's Ministry of Education prepared a master plan for adding computer skills in to their curriculum in 1997. According to this plan, IT based learning environment is maintained for every school. Ministry of Education

invested one computer for every two children and %30 of total curriculum covered by computer based learning.

Besides given IT supported education in schools, other training projects prepared for professional area. There was a huge gap between demand and supply of IT specialists. In 1997, total number of IT professionals was just 30.000. In order to increase IT awareness and provide training to large mass of employees, NCB and National Trades Union Congress (NTUC) started a project called IT Coach.

Main goal was to train employees and workers of factories and explain information and computer technologies from beginning. IT Coaches had computer, printer, camera, training schedule that covered 200 days and approximately each coach trained approximately 16.000 workers (NCB, 1992).

Cities are facing specific problems with the safety and security, including crime and violence, shooting, terrorism, these problems threat to the safety of citizens and cause a vast challenge to governments and city alike.

There is a growing demand for public safety to save the people in emerged disasters as soon as possible by the public alarm systems, for example, buildings that are located in areas that are likely to suffer from earthquakes, can be provided with the information technology systems and communications that can be communicate with the meteorological and geographical institutes to increase prevention and reaction time.

The aim of enchantment of environment to be “Smart” is to improve the quality of life for people by the provision of health and harmless living environments. Inhabitants in smart cities easy obtain the care services of health and varied public facilities, new health-care and elderly-care solutions are needed, a smart city has to be safe; a smarter safety initiative allows anticipating, rather just reacting, to problems (IBM Smarter City Program, 2010).

Critical Success Factors

- Increase health-care and elderly-care services availability, increase citizens' quality of life and satisfaction.

Contribution

- Usage of data that can predict where and when crimes will take place.
- To feed real-time information to fire and police departments.
- Cities are planning to make a public safety network that includes a first responder network, emergency dispatch and coordination, closed-circuit television (CCTV) and video analytics, the ability to create a virtual command center, and real-time delocalization information (Washburn et al,2010).

Healthcare System

A Smart healthcare system is built on scalable storage systems and a communication platform. Hence, patient records are electronically stored and shared wherever they are needed. The communication platform enables quick response to emergency services. Videoconferencing technologies facilitate remote medical center services to patients' homes, for those who cannot travel to hospitals (Washburn et al, 2010).

Environment

Basically smart city based on using technology to increase sustainability and management of natural resources better (<http://smartercities.nrdc.org>). Protection of the natural resources importance is related with infrastructure, such as Streams of water, sewage and green spaces such as parks (Hall, 2000). Together these factors have an impact on Sustainability and living city, where it should be taken into consideration when studying the smart city Initiatives.

A smart environment represents the link between what it is a physical and what it is a virtual to improve the quality of life and to facilitate adjustment processes that could be made to the physical environment, or in human behavior to improve the lived experience.(Smart Environment Vision Report,2011)

Lewis (2005) defined a smart environment as an evolutionary step in the buildings, homes, utilities and all city systems. Like any sensitive organism, the smart environment depends on first and foremost on sensory data from the real world. Sensory data comes from multiple sensors of different modalities in distributed locations. Smart Environment needs information about the surrounding areas as well as on internal methods of work.

Smart city aims to create a place that should be livable, attractive, comfortable and loved by its residents; smart city offers a unique combination of economic opportunity, vibrancy and a quality environment. Therefore, smart environment in smart cities is distinguishing the follownig (IMCSD, 2008):

- Air Quality - Cleaner air (Controlling Pollution)

- Improve Resource Efficiency
- Clean, Blue and Green Physical Environment
- Promoting a more environmentally responsible lifestyle
- Promoting resource-efficient buildings
- Making public housing more resource-efficient through innovative design and new technologies.
- Public cleanliness.
- Clean Technology and Sustainable Urban Solutions.
- More Parks and Nature-Based Leisure Options.
- Protecting and Enhancing Biodiversity

3.6.2 Hard components of Smart Cities

As suggested by scholar, the hard components of smart city include two main themes integrated and elaborated according to four previous scholars (Giffinger, IBM, Telefónica and Meeting of the Minds) and include (Mobility and Built Environment).

- **Smart Mobility**

Building a smart mobility means building a clean city, quiet environment and ban individual cars to from roads. Smart transportation is a critical solution in confronting the problems caused by increasing number of mega cities. The smart mobility infrastructure in smart city aims to make best use of transportation and maximize the traffic performance within the city, save energy and reduce carbon emissions.

Smart Mobility should have these characteristics (Integrated and Adopted by Scholar):

- Smart Parking

- Fleet Management
 - Intelligent Transport System
 - Traffic Management
 - Community Biking
 - Electric Vehicles Infrastructure
 - Smart Taxi
-
- **Smart Parking**

For transport planning and coordination of buses and trains; traffic movement information is being sent directly to travel people by smartphones, this helps passengers and drivers to know traffic situation and reduce congestion. Sensors embedded in the road Real-time provide information about parking spots and notifications whether there is an available space to park or no.

Example

San Francisco provides a service of information about the availability of parking spaces in real time through applications of a smart phone. Inhabitants can select free parking spots and price through a very easy application (Figure 9).

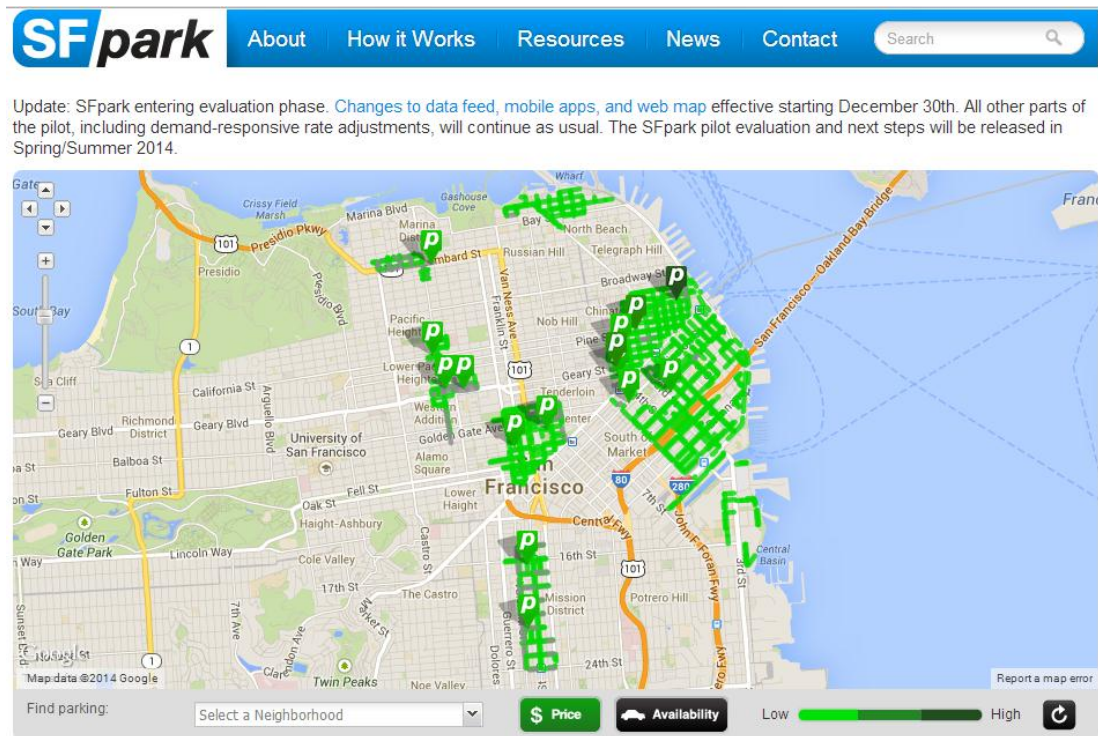


Figure 9: San Francisco's parking
 Source: <http://sfpark.org/>

- **Fleet Management System (FMS)**

This is solution for fleets of vehicles to define the position of all vehicle service engines in real time. It also produces various reports for the planning activity, to encourage savings and improve the quality of service perceived by the citizens. Basic function in all fleet management systems is the vehicle tracking and usually based on GPS, once the car location; the direction and speed will be determined by the GPS mechanisms, additional tracking capabilities transmit this information to the fleet management software application. Users can see the real-time locations of their fleet on the map. This is often used to respond quickly to events on the ground ([www.hitachi-automotive](http://www.hitachi-automotive.com)).

Example

Ottawa city in Canada updated its services to the public to be safe, reliable and effectively cost. Ottawa vehicles include buses, ambulances, fire trucks, equipment for snow removal and solid waste vehicles. Fleet management system ensures the provision of vehicles services in the city in order to fulfill their obligations to the public and get rid of the aged cars in the suitable time. This system is complied with the requirements of the vehicle safety equipment. (<http://ottawa.ca/en>).

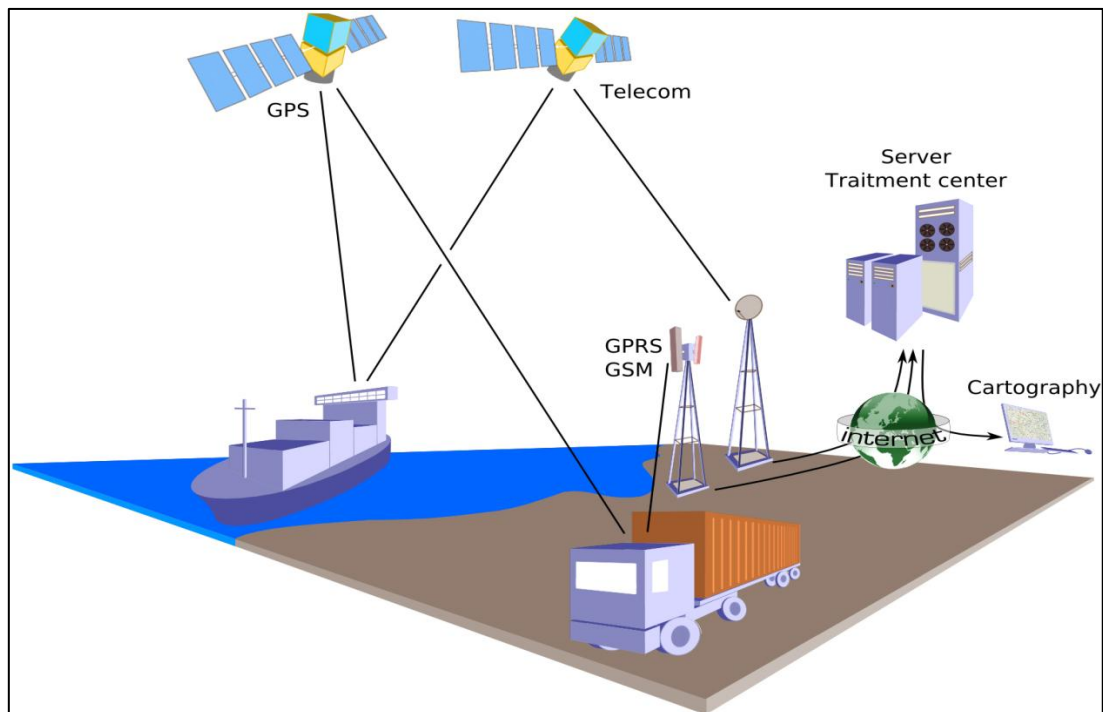


Figure 10: San Francisco's parking

Source: <http://sfpark.org/>

- **Intelligent Transport System (ITS)**

The developed countries around the world such as Japan, U.S., Germany, and France that have highways are already installed a large number of Intelligent Transport System (ITS) which is a new set of techniques and methods to meet the challenges that rise to the surface of transport. Applications of intelligent transport system (ITS)

meet the challenges of today's traffic, and improve the operational benefits to the transport system by reducing delays and allow traffic to flow smoothly (GPS World, 2014).

Example

Japan activated ITS services since 1996 to provide drivers with public roads information collected from roads operators and traffic police centers without any fees (Figure 11). Japan implemented five million units of ITS to help drivers find efficient, way to their destination thereby reducing traffic congestion, besides that this service has contributed to reduction of 2.4 million tons of CO₂ emissions. Toyota, Honda and Nissan are the pioneers in provide users with traffic information based on detailed data of their investigations, when the disaster occurred on 11 March 2011 in Japan; several roads in the North East were destroyed and there is no general traffic information from the region, but within eight days after the disaster; drivers were able to get the data from systems either by website or via smart phones (Hayakawa, 2013).

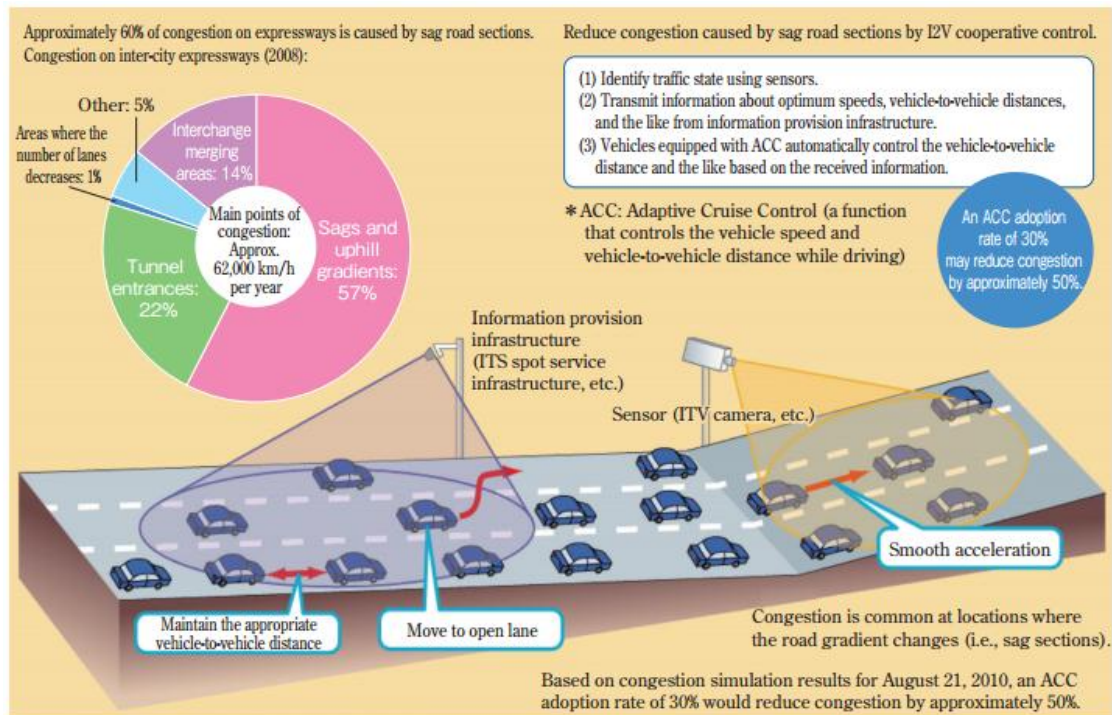


Figure 11: Intelligent Transport System

Source: Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

- **Traffic Management**

The provision of smart traffic light and send traffic information to people by mobiles; will improve the perception of citizens about travel times, and also increase the use of public transportation performance which reduces the use of private vehicles and facilitates management of the road network, in turn increases the public transport services quickly. As a result, this trait helps to reduce emissions associated with each trip, so that emissions from public transport are less than private vehicles.

Example

Barcelona has a mobile application that makes it easy to visualize traffic in real time. It allows the user to determine the best route to avoid congestion and accidents, and thus save time. The user can also see the images received by 30 cameras stationed around all regions, which are updated every five or ten minutes.



Figure 12: Traffic Management

Source: <http://latitudefortyone.com/ten-reasons-why-barcelona-is-a-smart-city/>

- **Public Bicycle**

A major proportion of traffic in any city is a large number of cars, vans and trucks, so using bikes would contribute to decrease this proportion. Implementation of public bicycle is important for reducing the pressure on public transport and improving health. Infrastructure of should be deployed throughout the city to share bikes for short periods with information in real time about the availability and the reservation of the bikes at the station.

Example

Copenhagen wheel project is a new mobility initiative in urban areas, it is responsive an elegant system, it converts ordinary bikes into hybrid e-bikes by hyper sensor units. Copenhagen wheel project allows you to capture the energy while cycling and braking and save it for when you need to fuel; it also shows by maps the pollution levels, traffic congestion and road conditions in real time.

Copenhagen wheel is controlled through by smartphones; riders can use phone to open and lock their bikes, change gears and determine how much the engine can help. As well as the turn of wheel sensor is captured the level of effort and information on your surroundings, including road conditions, carbon monoxide, noise, ambient temperature and relative humidity.

Access to such data through the phone or the network is to help users for planning routes and to achieve the objectives of the process or to meet up with friends; also riders can share their data with friends (<http://senseable.mit.edu/copenhagenwheel/>).



Figure 13: Copenhagen wheel project
Source: <http://senseable.mit.edu/copenhagenwheel/>

- **Electric Vehicles Infrastructure**

These procedures aim to connected "smart mobility" to make effective mobility available with environmentally friendly effects. Greatest corporation processes

carried out in cities and municipalities under this trait is the best meeting of transport requirements of inhabitants with the intelligent usage in the city, resulting in a change from singular transit to mass transit, and boosting the using of non-motorized transport such as bikes and electric cars. Electric vehicle network is a system of infrastructure charging stations and probably stations for recharging the battery electric car swap. The Governments, manufacturers and infrastructure providers distributed several stations to create such networks for charging infrastructure with real-time information from the nearest stations, and make booking available in all time periods and accessible from the smartphone and web applications (Meeus, Delarue and Glachant 2011).

Example

Madrid allows users to hire electric car (economic and friendly environmental) and drive it throughout the city. Moreover, the City Council allows these cars to park in restricted areas and drive through the residential areas of priority (Figure 14).



Figure 14: Madrid Electric Car

Source: <http://www.getyourguide.com/madrid-146/madrid-electric-car-rental-with-gps-t39049/>

- **Smart taxi**

Location of taxis and the booking tool are available on the mobile applications. Taxi user can determine his/her position to find the nearest available car (equipped with location information provided in both taxi and mobile application). In addition to features include billing and other capacities.

Built Environment

Smart built environment includes smart buildings, smart lighting, smart grids, water and waste management, safety and security; all these systems are elaborated as following:

- **Smart Buildings**

Smartness here means infusion of technology in buildings (residential and non-residential), which is related to energy supplies, automation and control, lighting, heating and the efficient use of available water.

Smart management systems in buildings help to reduce energy costs and CO₂ emissions from 20-30%. Building automation systems (BAS), intelligent networks of electronic devices, monitoring and control of power supply systems, lighting, heating, air And water management, as well as security systems (For example, toxic substances and fire safety) in integrated network is reduced maintenance and energy costs to a large extent.

Buildings really will be “smart” and high-energy efficiency and intelligent automation when they are accompanied by integration energy supply technologies of

low-carbon, the possibility to communicate with the smart grid. In the future, new buildings will have very low power consumption.

Smart buildings mean not only the connection to the Internet, or remote control, what makes the house “smart” buildings is the existence of devices that can alarm the emerging situation data both inside and outside the home, and turn out to be useful information for use by various users (Figure 15).

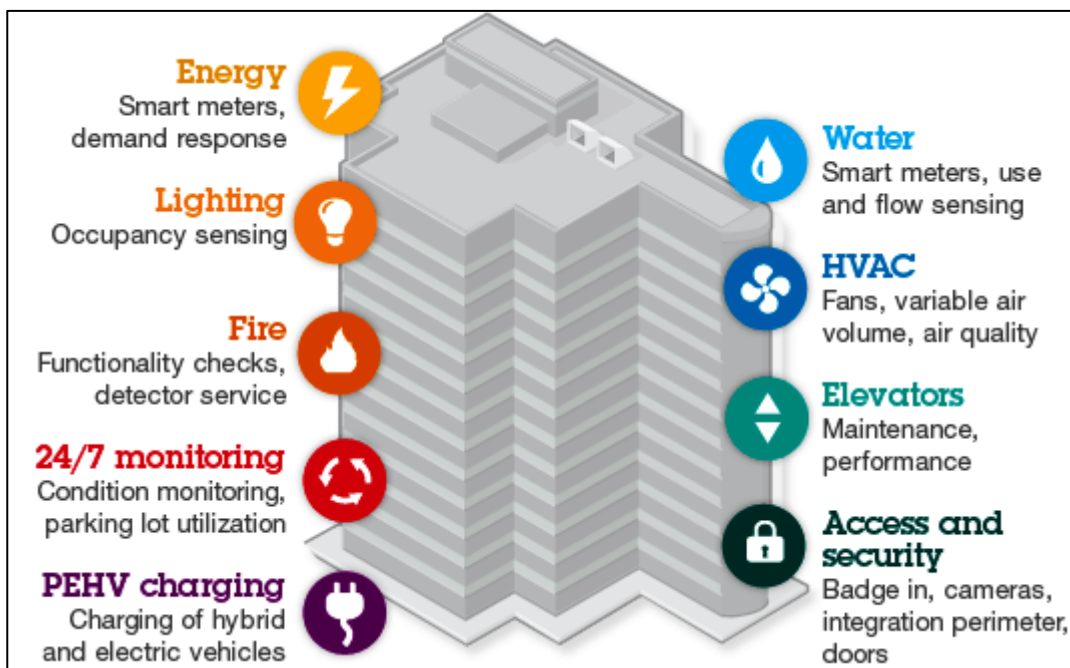


Figure 15: Smart Building systems
Source: The IBM smarter buildings Survey. April 2010

- **Smart lighting**

Lighting technologies have passed the major developments in the last years, offered a new perspective in the cities, and added the possibilities for the development of these urban areas lighting strategies. Natural daylight is necessary for life. In the cities is the need artificial light to help citizen’s fulfillment of visual tasks, where summer is not available everywhere and at any time. Light effects on our mood; Improves the

well-being and biological processes. Light stimulate productivity and accommodates 24 hours lifestyle, and ensure the safety and comfort even for aging people.

The good lighting in cities provides many benefits, to:

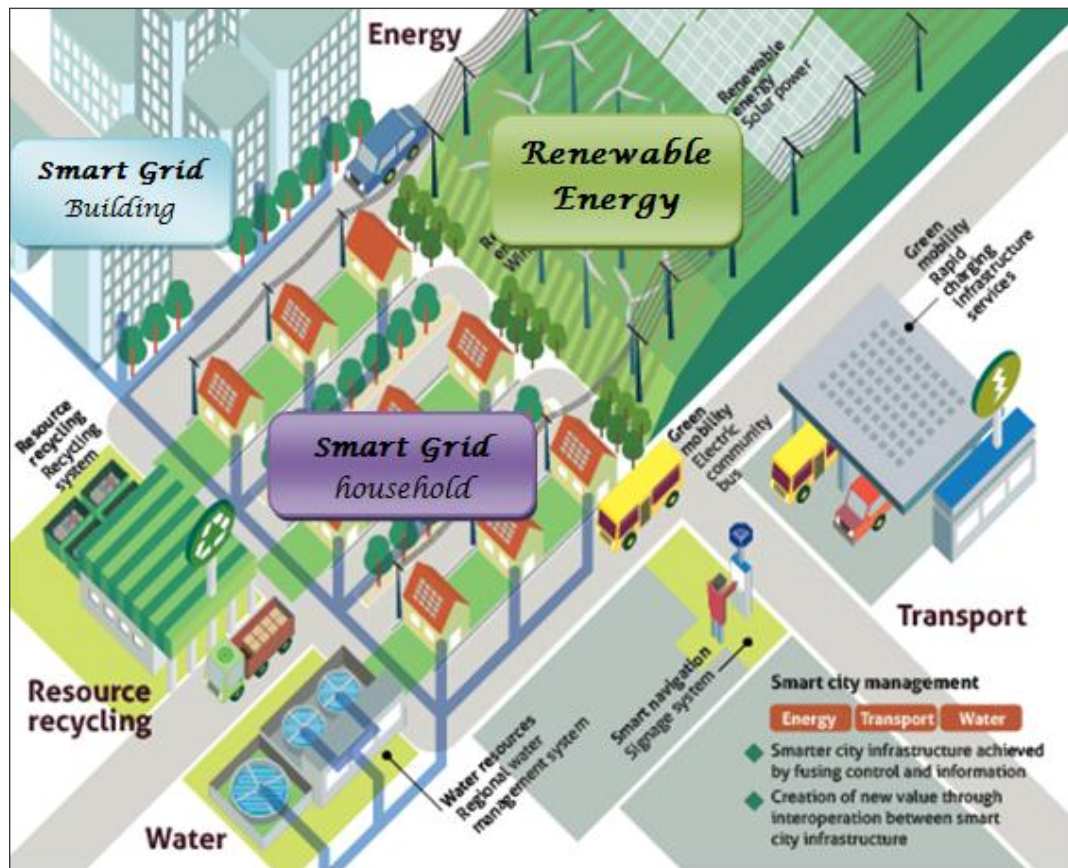
- Improve the quality of urban and city social and cultural life.
- Beauty appearance of architecture and urban landscapes in the city.
- Increase the visibility of all visual tasks.
- Improve the safety and usability of streets and roads.
- Motivate and encourage learning and study.
- Improve productivity, and enhance the safety and accuracy in the workplace.
- Stimulate the benefits and experiences for retail sale and leisure environments.
- Deal with emerging challenges of demographic change and after aging of the population in the cities.

Society puts great importance on the climate and power protection. Lighting can play a central role in cities in the conservation of energy, resources and costs. New lighting techniques and controls can achieve savings at least 40 % (Electra II .2002).

- **Smart Grids**

City cannot be a smart city without the process of the smart grids working correctly. Grids of city require many technical solutions to cope with problems and threats. City needs to be able to deal with the renewable energy sources while generate green energy from the large amounts of renewable, such as wind, solar and hydro power. Smart grids should be taken as holistic integrated system not only on the individuals,

city will be a smart when all components of the network could communicate with each other in order to reduce greenhouse gas emissions and increase efficiency (Figure 16).



. Figure 16: Smart Grids

Source: <http://www.greenpurchasingasia.com/content/smart-cities-tomorrow>

So, if cities continue to grow at a sustainable, an integrated program of smart grid technologies must be organized and information and communication technology such as SCADA (Supervision Control and Data Acquisition) is fully dedicated smart grids are necessary.

The smart grids system will evolve the production and consumption of electricity in a cost-optimized and environmentally responsible way. Another priority is to achieve a

balance between full power (High, medium and low voltage currents), and the system in particular by the capacity of the energy storage.

- **Water and Waste Management**

According United Nations, all over the world, people live at least 1.2 Billion in areas of water scarcity. This problem is now recognized the greatest risk of resource century atheist century. It is necessary Cities that address the perception of low value for water. One of the major cities problems is water management, the pressure on water resources increases in all cities over the world, there is a growing need to reduce water use and increase water reuse. Using the technologies in management water represents the key factor in decrease the costs of production of drinking water and water generally.

When using the latest technologies is available, a higher level of efficiency will be achieved to reducing the operational costs, as well as efficiency in operation of the water system is very important in the city. Water supply and treatment are major users of energy; about 30 % -35 % pumps are sold globally for the water industry. In the fact any reduction in the cost of energy used not only affect the quality of service, but also on the cost of direct Citizens.

In addition, the use of waste materials as a source of renewable energy is crucial to the health of our cities in the long term. When considering the electrical energy used by distribution of water in urban areas, pumping systems and this represents about 20% of electric power used in the city. Many of these systems have potentiality for energy saving of 30-50%.

Solutions are already available for better water management pumping stations such as the automation of optimal pressure management.

Even in the field of water management, as well as the treatment of sewage Requires more attention from the relevant authorities. Moreover, the aspect of energy directly affects service Continuity and operational costs. Waste management in the cities is the other key element, which, if taken incorrectly, direct impacts on quality of life of citizens (IBM 2009).

Chapter 4

INTERNATIONAL CASE STUDIES ON SMART CITIES

4.1 Introduction

Numerous of the main cities in the world have launched smart city projects, including Seoul, Singapore, Amsterdam, Barcelona and others. Smart city is still considered as the city of future, and according to the ratio of invention today, it is very probable that this model of city in next years becomes a very feasible and very popular applicable city.

This section aims to shed light on the dominant features in the hard components of smart cities. By selecting practical paradigms from four smarter cities in the world we can examine what the significant and dominant features were implemented to achieve the smartness in the city and what features were not according to the adopted framework of components of smart cities in term of soft and hard components.

First four ranked smart cities in both Asia and Europe continent will be the case studies to achieve the aim of analysis. The selection of four cities is based on the ranking developed by American researcher Dr. Boyd Cohen and published in 2013 in the online magazine “Co. Exist” (<http://www.fastcoexist.com/>).

The first two ranked cities in Asia are: Seoul and Singapore (<http://www.fastcoexist.com/3021911/the-10-smartest-asia-pacific-cities>), while in

Europe are Copenhagen and Amsterdam (<http://www.fastcoexist.com/3024721/the-10-smartest-cities-in-europe>).

4.2 Seoul Smart City

Officially, Seoul is the capital of South Korea with a population of 10 million people and area about 605.2 km². Seoul has advanced economy and tourism; as well it was ranked number 1 in the order in United Nations e-Government Survey since 2003.

Seoul was announced in June 2011 as a leader in information and communications technology, and became a smart city by different ways, as Seoul case these ways are: supporting the competitiveness, improvement the sustainability, and achieving gladness for the people. Smart City approves constant maintenance, safety and promotes the renewal of its attraction in the future.

Smart Seoul adopted restrictions to apply information and communication technologies in existing infrastructure in the traditional parts of city and enhanced the provision of public facilities such as mobility, safety as well achieving enhancements on the quality of life for its citizens in Seoul.

In 2004, Seoul started the project of U – city (Ubiquitous City) where the city applies technologies everywhere to enhance its competitiveness.

Smart Seoul project is more concerned with people and now goals to set many of the smart technologies to create more accommodated connection between the city and its inhabitants.

4.2.1 Phases for the Smart City

Seoul followed three comprehensive stages for the developing of a Smart City:

First phase: The level of singular services through implantation of information and communication technology to improve the operations of the city, such as environment, transport, culture and safety.

Second phase: The vertical administration level; incorporates related procedures and services by implementation of high technology inside main parts of a city, allowing the provision of more innovative services. By taking the transportation as an example, citizens are obtaining information on the public transportation system's real-time activity as well as disasters, road situations, road maintenance and consequent diversions. Citizens are noticing increases advancing in the value of service in all sectors of city although smart city services are not yet combined through all sectors.

Third Phase: this phase represents the horizontal level of service which aims to improve city through adding obvious characteristics between the different service parts, all the parts incorporate Eco- efficiency within the smart city systems.

4.2.3 Three Features of Smart Seoul

Cities put their distinctive priority when developing a smart city, but all the smart cities should show three essential features: Infrastructure, Management and People (ITU-T report, 2013).

Infrastructure

Safe infrastructure for information and communication technology considers as a substantial role to the success of developing Smart city services. Plans to develop the infrastructure for information and communication technology should expect service needs in the future.

Smart infrastructure refers to the pack of information and communication technology to provide basic efficient Services. Improvement of services is led by the administration of the capital. Seoul Government is currently transferring the largest part of the jobs for its citizens through distribution of information management in the city and establishment of open-source application development models.

- **Free public Wi-Fi**

Smart City based on the establishment of a comprehensive network for habitants, with the increasing of population of the city, the demand on establishment of services will increase as well. Seoul installed a free Wi-Fi network in gardens, plazas, subways, trains and buses, subway. In addition, the governmental administrative provided free Wi-Fi network to citizens visiting its public buildings.

- **Smart Meters and Smart grids**

Korea aimed to reduce total energy use in the city, therefore undertook to install of smart meters in houses buildings and factories, Seoul has launched the development of smart grid systems, and concentrating on CO2 reduction and this can be considered a very striving target since the industry. Green Growth

Enterprise push towards sustainable development, Seoul began the national project “smart grid” which can help to estimate climate change, and achieving reduction of gas emissions. Smart grid initiative is a national policy because Korea will help achieve the vision of low-carbon growth. The aim of this is determined by the initiative in the vision “to build an advanced green country.

Management

This feature is important to integrate the admiration operations systems with singular systems to work as one system, the building of Smart City will work in harmony only through precise following to public standards.

- **Seoul U- Net**

Seoul created communications network services and established in 2003 Optical network management called “e- Seoul Net” includes a fiber-optic cable along the subway to link the public buildings in the city with its associated offices and municipalities. Officers can contact from affiliated offices in order to exchange data with main administration, and citizens can access to administrative services at any time and in any place. In the future, plans to take advantage U - Seoul Forum in areas such as child safety, and emissions from vehicles control systems are able to reduce energy costs in the city.

People

Information and communication technologies are tools to enable the citizens to interact with smart services and utilize the benefits of smart technology. Increasing access to education in their use, intelligent devices through income levels and age groups, remain the top priorities for the city smart.

- **Smart Work Center**

Seoul Metropolitan Government is leading the project "Smart Work Center, which allows the governmental workers working from Work Smart Centers, placed very nearby their homes. Seoul Metropolitan Government launched the first Smart Work Centers in August 2011; this initiative has brought the attention of people and governments in the world.

- **Safety Service**

Safety service has been setup since April 2008; by using this trait people can determine" based on the location services and technology their family members for emergencies involving children, disabled, ageing and people who suffer from Alzheimer's disease (Figure 17).

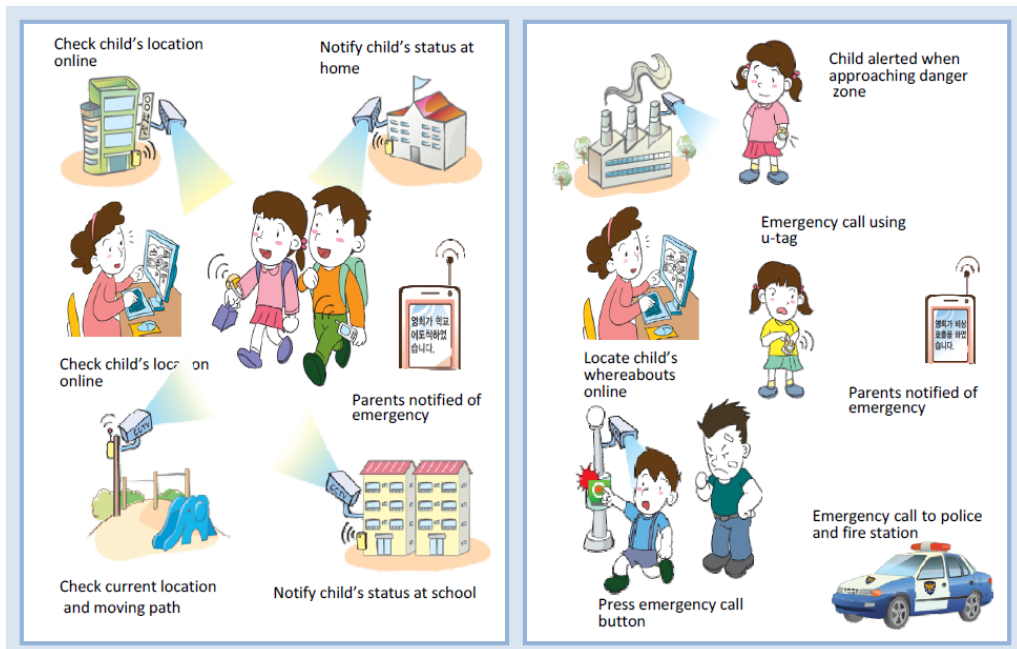


Figure 17: Safety Service
Source: Smart Cities - Seoul a case study

4.3 Singapore Smart City

Singapore is an island lies in Asia continent, with 716 kilometers area and population of 5.4 million (<http://en.wikipedia.org/wiki/Singapore>). Singapore is not only small but almost without any natural resources even the drinkable water is coming from neighbor Malaysia by pipes. People are most important resource that government depended on in its attempt toward the “smart” and also embarked enormous programs to build the essential infrastructure, the ultimate goal is not just economic growth, but enhance the quality of life for all people, making Singapore smart.

Singapore became independent in 1965; at 1980s Singapore government began to emphasize the need to develop the service sector in addition to manufacturing and trade in goods .After that the trade in low technology increased clearly, which led Singapore to be in competition in technology and information creativity.

The case of Singapore is distinctive and differs from other cities. The government began numeral plans to achieve transformation toward smart city. The insertion of technology in the daily life in the city began with the 1980s; successive governments played essential role this domain. In Singapore, the transformation to technology was not limited, but also attachment of citizens in the process of transformation was present and active.

Singapore set its conceptual plan of development for 40-50 years, aiming to create a good environment for the residents living in the future with a limited area of land. Conceptual plan of development does not remain constant and unchanging, but it is updated every 10 years, in addition policies and developments .Conceptual plan of

development of Singapore approved in 2001 ,aims to create a cosmopolitan city with a population of 5 million , dynamic , livable, and adapt to the changing global standards. The major focal points of the development plan are Economy, People, Governance, Mobility, Environment and Living.

4.3.1 Economy

The availability of competitive economy is essential to the development of city. All people must find an opportunity to earn money and living to achieve a degree of economic Security. Government should be able to create more jobs and investments to enhance the economic growth. Singapore had a key role to support the country's economy development. This includes the allocation of land and facilities for industrial uses, transportation networks, water supply and the provision of sanitation facilities. These economic policies were also a dynamic and adaptive to change the global conditions (Chye, 2012).

In order to keep its position as an international business hub, Singapore has to elaborate its information economy. E-commerce can be stated as an important term under information economy. Also communication systems work as a technical infrastructure supported by administrative and legislative systems. Citizens' online presence and online transfers have to be validated legally. Intellectual property rights are another important term and have to be protected over internet. Security of personal and financial data of citizens is also another issue in information economy.

Electronic Commerce Policy Committee (ECPC) is established by 1997, prepared list of advices to government which creates a framework for e-commerce in particular:

- Private sector should be a leading actor for developing electronic commerce.

- Government should create legal framework which is constant and reliable environment.
- Government should provide a secure and safe environment.
- Government has to be a catalyst for the growth of e-commerce by joint ventures.
- Policies have to be innovative and transparent.
- E-commerce regulations have to be compatible with international regulations and actors.

According to this e-commerce framework, government has an important role in business development by being a partner in joint ventures. These joint ventures make government an active business partner and investor in e-commerce. In other countries, governments stay away from these kind of business involvement and take role as a regulator.

4.3.2 People

For Singapore, IT skills is required not only for business or industry but for everyday life. Ability to use computer is become a must skill for education like reading, writing and arithmetic. Singapore's Ministry of Education prepared a master plan for adding computer skills in to their curriculum in 1997. According to this plan, IT based learning environment is maintained for every school. Ministry of Education invested one computer for every two children and %30 of total curriculum covered by computer based learning.

Besides given IT supported education in schools, other training projects prepared for professional area. There was a huge gap between demand and supply of IT

specialists. In 1997, total number of IT professionals was just 30.000. In order to increase IT awareness and provide training to large mass of employees, NCB and National Trades Union Congress (NTUC) started a project called IT Coach.

Main goal was to train employees and workers of factories and explain information and computer technologies from beginning. IT Coaches had computer, printer, camera, training schedule that covered 200 days and approximately each coach trained approximately 16.000 workers (NCB, 1992).

4.3.3 Governance

Prior to 2005, all government agencies began offering their services from the public stalls to get and follow information and electronic services. The government involved citizens to play an active role in shaping and defining e-government services and transformations with the help of information and communication technology.

Government information and services are brought together under one portal. The Singapore Government Online Portal (www.gov.sg) launched in 2004 and positioned as the Internet gateway to all government information and e-services. By 2005, all government agencies started to give their services from public kiosks in order to access information and e-services (www.gov.sg).

Government tried to engage citizens in to play active role in the formation and definition of e-government services and transformations by the help of ICT. Government tried to explain different aspects of online transformation of public policies to the citizens in order to optimize and to be claimed (www.gov.sg).

In 2011, Singapore initiated a new e-Government Master Plan (2011-2015) called e-Gov2015. Plan's vision is to be a collaborative government that co-creates and connects with citizen participation. e-Government 2015 is targeting to create an interactive environment where government, private sector and citizens work together by ITC technologies(www.gov.sg).

4.3.4 Mobility

Singapore developed its transport capacity although the limitation of land for roads, also established public transport networks over all city. Singapore was the first in the world to charge Ride to reduce congestion in the city, one of the most important traffic management application of Singapore is road pricing systems which serves as an effective tool for manage traffic congestion Road pricing was first implemented as Area Licensing System that charge of fee for each vehicle enters to Central Business District. Later, this system replaced with Mobility. Radio Frequency Identification (RFID) technology used for charging free while vehicle passing under a toll gate (Karadağ, 2013).

The ERP system provides a target oriented solution for congestion pricing, enable the authorities to focus on specific points of congestion. Therefore, the charges can increase or decrease according to demand of usage of the roads or highways, which is reviewed quarterly. By pricing congested sections, the ERP system helps to moderate and spread the use of vehicles for optimal use of the road network by encouraging drivers to consider alternatives. These alternatives include the use of other routes, traveling during low demand periods, orienting to the public transportation or carpooling which is the sharing a car to a destination to reduce fuel use, pollution and travel costs (Karadağ, 2013).

4.3.5 Environment

The vision for Singapore is for it to be a lively and livable global city that is loved by its residents; the city will offer a unique combination of economic opportunity, vibrancy and a quality environment. Therefore, Singapore set many procedures to achieve this vision (IMCSD, 2008):

- Energy - Greater Efficiency and Diversification
- Enhancing Water Security and Efficiency
- Promoting Waste Minimization and Recycling
- Air Quality - Cleaner air (Controlling Pollution)
- Improve Resource Efficiency
- Clean, Blue and Green Physical Environment
- Promoting a more environmentally responsible lifestyle
- Promoting resource-efficient buildings
- Making public housing more resource-efficient through innovative design and new technologies.
- Stepping up public cleanliness efforts to make the city cleaner.
- Promoting Clean Technology and Sustainable Urban Solutions.

4.3.6 Living

- Creating More Parks and Nature-Based Leisure Options, provided 0.8ha of park land per 1,000 persons.
- Make parks more accessible, by tripling the length of park connectors from 100 to 360km and developing new leisure options around green spaces.
- Promoting Sky rise Greenery, add some 30ha and 50ha of sky rise greenery including 9ha of green roofs on multi-story car parks in public housing estates.

- Introduce various initiatives to promote sky rise greenery; this includes green roofs.
- Protecting and Enhancing Biodiversity, implement a National Biodiversity Strategy and Action Plan to research, document and conserve biodiversity in Singapore.

4.4 Copenhagen Smart City

Copenhagen is the capital of Denmark, has about 550,000 inhabitants and area of 88.25 km² (City of Copenhagen, 2012). It is regularly ranked number one among smarter European cities (<http://www.fastcoexist.com/3024721/the-10-smartest-cities-in-europe/>).

Copenhagen was having an ambitious vision to become a smart city and the first carbon neutral capital in 2025, in order to reach this ambitious goal, it determined to implement new and innovative solutions in the field of transport, waste, water and energy resources, improving the quality of life, innovation, job creation and investment.

The way to Copenhagen is based on a dual strategy: firstly, Copenhagen to be the first of all smart cities in the world and pioneer of sustainable solutions; to facilitate this goal, the city focused on cooperation between public authorities and private companies to set a long-term strategy . Secondly, sharing successes and knowledge gained in the city with other cities in European Union.

There are many reasons why Copenhagen can be considered as Smart City, a number of current studies and discussions refer to this property is due to the development

program launched by municipality which is working systematically to employ ICT in the city.

Here, we could refer to the most important themes followed by municipality to develop its city:

4.4.1 Climate and Environment

Copenhagen has a long-term strategy in processes relating to environmental and urban development that lead the city to become the first in the world in low CO2 emission. Moreover, the first urban planning legislation backs to 1925, this holistic tradition comprehensive planning continues today, and it is one of the main reasons why Copenhagen is smart city. Besides, the Danish political climate Green solutions support the partnership between the public and private sectors, and brings together all the leading players in the fields of energy, climate, water and the environment under a common vision of Denmark State.

4.4.2 Technology

Technology in the physical infrastructure of the city is crucial way to support provision of services of people; it has led to extensive efforts to create green areas such as parks, green roofs and facades of green buildings; which, the technology is important in perspective of sustainability. Technology could be appeared in a number of “digital devices” along roads (such as broadband, cloud computing, fiber optic cable), and at the end the actions will be taken by different people.

The city depends on smart devices in its parts of physical infrastructure to be able to connect and improve its efficiency, in the smart city; the physical infrastructure depends on an integrated digital sensors and smart meters throughout the city which

can provide digital information technology about traffic flow, parking vacancies use of space, energy, auto accidents and weather.

Besides physical integration and digital infrastructure, the infrastructure needs to be integrating as well to be able to all devices communicate with each other through the same the language, this requires not only arise in the digital encoding language but also calls for common ground with the smart users of Technologies. Furthermore, computer systems and databases should be able to connect and feed into each other in the public and private sectors, as well enable smooth and efficient information flow between the different stakeholders in the city.

4.4.3 City Administration

The system of government is developed along with the development and integration of new technologies development to leave the work of traditional governance policy and focused on more horizontal solutions that foster cooperation and networking between the various actors in the community. As things look now, much of the knowledge is needed for smart city solutions and in different processes in any management activities.

At the political level, open data has been implemented in decision-making process where open data is new way to organize the public sector. In 2009, a new strategy called “General Data” began in Denmark to display the initiative as a whole way of thinking about digital content and a way to involve citizens and consumers in create new solutions by giving them access to general statements. The goal of this is to create an access point where data is assembled and taken all the economic aspects, legal and practical care.

4.4.4 Society

Denmark generally improved the infrastructure and digital communication between public authorities, businesses and citizens, this led Denmark to become one of the leading countries in the world in Management of e-Government according to United Nations e-Government Survey 2012.

This characteristic of online authority which provides online information from websites allows citizens to contribute to smart city developments. Most common users of the internet and social media share valuable data about their lives, which can be used in the process of innovation for new smart products or services to create a good chance to city to become smarter.

4.4.5 Smart Grids

Copenhagen used smart grids which it means using a new kind of power grid to take advantage of software tools and hardware control and management transmission of electricity from all sources of generation. This in turn provides for more information about the flexibility of the process of the transfer of energy and less waste, which is able to integrate local and decentralized energy electric generators such as solar panels, wind turbines, heat pumps.

This kind of grids reduces the loss of power in process of transmission, moreover, the electricity supply needs to achieve a balance between the demand for all times to generate electricity to meet the demand for energy. This, of course, is very effective and friendly environmental. Also, integration of new sources of energy makes energy systems more intelligent the electric power grid more flexible.

4.4.6 Mobility

The plan of Copenhagen in mobility is to make all trips in city by foot, by bike or public transport, now 50% of trips to work or school in Copenhagen is by bike, and 20% of passengers are using public transport.

When Public transportation has increased, the carbon emission decreased 20-30%. All small vehicles used to new types of fuel such as electricity, hydrogen and biogas or ethanol, and the heavy vehicles using new Bio-fuel. Copenhagen also developed the networks of public transport and implanted intelligent traffic management to improve traffic flow and reduce congestion.

4.5 Amsterdam Smart City

Amsterdam is the capital of the Netherlands with a population of 1.2 million inhabitants from 175 different countries and area 219.4 km² (<http://en.wikipedia.org/wiki/Amsterdam>). Amsterdam aims to become one of the most smart and sustainable cities in the world by 2040. The distinctive collaboration between businesses, researchers and the people is helping Amsterdam to achieve this goal. This idea launched in 2009 and has grown into a wide platform, with more than 70 partners participating in a variety of projects focusing on energy and open communication open. This idea encourages sustainability and active participation of citizens to the new technologies for best place to live.

Amsterdam Smart City (ASC) is a program that facilitates and improves the performance of business, governmental operations and academic institutions. This program consists of a dedicated team who believes that by combining knowledge, competencies and partners, the development of the city and quality of life will be

better and creates more jobs. ASC does not believe only in a top-down approach, there is a strong belief in that bottom-up ideas can contribute significantly to the city development, especially when it comes to new product development and services (Baron, 2013).

The main goal for Amsterdam to be smart is to reduce of CO2 emissions in compliance with targets set by European and national criteria, and also considers the development of cities creates open infrastructure where companies and users can access and deploy new products and services (Baron, 2013).

For the development of Amsterdam and achieve the smart city, ASC laid out two lines of action (Baron, 2013):

1. Encouragement of the development of new products and services

The aim is to improve the quality of life of people living and working in the city and solve their social problems. During the first three years of the program of Amsterdam Smart City this action passed in two passes; the first is creating cooperative models and enable data access for users; the second is started in 2012 by focusing on shifting to create models for users with all possibilities (Baron, 2013).

Project that is implemented in the Amsterdam, sometimes directly managed by the association, but most of the time by other parties in Amsterdam, generally can be divided into three categories; energy, connectivity and data, although it applied the same principles to other sectors; including health, education and tourism (Baron, 2013).

2. Undertaking open infrastructure and State-of-the-art

The aim is to enable the required products and services. Due to new demands on flexible and best services, the need to new infrastructure requirements is very important to achieve this goal. During the 20th century, the city has focused on the traditional infrastructure such as roads, metro/tram systems, buildings, energy and water. While in the 21st century, the city has developed the roads, housing and public transport, as well managed infrastructure water and energy by the smart devices. Investing in broadband and smart energy networks created a developed infrastructure in all city parts (Baron, 2013).

4.5.1 Themes of City

The objective of ASC project is to develop the capital Amsterdam into smart city; the project focused on five themes to achieve this goal:

- Living
- Working
- Mobility
- Public Utilities
- Open data

- **Living**

Amsterdam is the largest city of Netherlands with more than 400,000 families; these families are responsible for about one-third of the total CO₂ emissions in Amsterdam. Smart technologies greatly decrease the economy in energy consumption, CO₂ emissions and energy consumption. There is a lot that can be achieved by creating awareness among the population regarding the use of energy and behavior. The application of smart technologies can determine which methods

and techniques are more effective; create different projects and renewal of old buildings along the canal installation of smart meters.

- **Working**

There are a lot of companies and activities that are located in Amsterdam, from small bakers to multinational companies; they are located in buildings ranging from the old canal houses of the steel and glass towers. The smart factor in using the techniques and methods will create different effective projects, with a focus on real estate and corporate operations to convince people to work smarter, for example, the use of a business smart instead of spending time in congested traffic.

- **Mobility**

Mobility and transportation including all means like cars, buses, trucks, motorcycles and cruise ships account for about one third of the total CO2 emissions in Amsterdam. In order to identify the technologies, concepts, approaches and forms of cooperation to succeed, ASC project created different projects in this sector, focusing on sustainable transport and infrastructure required to achieve smart mobility; for example, application of new concepts, logistics, dynamic traffic management concept, and a network of recharging points for electric scooters throughout the city.

- **Public Utilities**

The municipality of Amsterdam played important role in providing services to stakeholders in the region including; public places, buildings and means of transport. The municipality of Amsterdam implemented most successful methods, approaches and forms of cooperation to make the facilities more sustainable and smarter

projects. The focus was on the theme of public service smart solutions in schools, hospitals, sports areas, libraries, streets, etc.

- **Open Data**

Amsterdam has an active program "open data". This consists of a number of separate activities, all that is needed to stimulate the development of "open data". Main concerns is to create applications models and organizing site (platform) of the data; that can be used to provide new opportunity to make decisions based on the facts and the actual figures. The concept of "open has become vitally important to government historically of which relate to the quantities of food available, and the collection of taxes or registration of the population, may this concept play an important role when it comes to data collection and management.

4.6 Final Findings

Following table is a comparison among four first ranked smart cities in world in term of area, population, project commencement and domains of project:

Table 2: Comparison among first ranked smart cities in the world

	Seoul Smart City	Singapore Smart City	Copenhagen Smart City	Amsterdam Smart City
Area	605.2 km ²	716 km ²	88.25 km ²	219.4 km ²
Population	10 million	5.4 million	550,000	1.2 million
Project Commencement	2011	2004	2012	2009
Domains of Project	<ol style="list-style-type: none"> 1. Infrastructure 2. Management 3. People 	<ol style="list-style-type: none"> 1. Economy 2. People 3. Governance 4. Mobility 5. Environment 6. Living 	<ol style="list-style-type: none"> 1. Climate and Environment 2. Technology 3. City Administration 4. Society 5. Mobility 	<ol style="list-style-type: none"> 1. Living 2. Working 3. Mobility 4. Public Utilities 5. Open data

Following table is a comparison among four first ranked cities in world to show the common features that have been considered among those cities, as well to specify the outstanding features that have been considered in each city (Table 3).

	Seoul Smart City	Singapore Smart City	Copenhagen	Amsterdam Smart City
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				Smart City	
Soft Components	Governance	Seoul u- net	E-government, citizen participation	General data, citizen participation	Public service smart solutions, open data
	Economy		E-commerce, security of personal and financial data of citizens, joint ventures	E-commerce	Encourage working, estate investments
	People	ICT in education, smart work center, safety service	ICT in education	ICT in education	Increase quality of life, data access
	Environment	CO2 reduction, green growth	Controlling pollution, sustainable urban solutions, clean, blue and green physical environment Waste minimization and recycling, enhancing biodiversity	Low CO2 emission, climate green solutions	Reduce of CO2 emissions
Hard Components	Mobility	Real time	Road pricing to reduce congestion,	Bike community, digital, enhancing public transport, electrical vehicles, digital devices along roads.	Sustainable transport, traffic management
	Built	Free public Wi-Fi , smart meters and smart grids	Efficient buildings, green roofs. Multi-story car parks	Green roofs and facades, digital sensors and smart meters, smart grids,	Broadband and smart energy network

Table 3: Features in the first ranked smart cities in the world

So, by incorporation of all previous findings in four first ranked cities in world and their outstanding features that have been implemented, we can infer that following are the most outstanding domains and features in smart cities (Table 4).

Table 4: Outstanding domains and features in the smart cities

Soft Components	Governance	E-government, citizen participation, public service smart solutions, open data
	Economy	E-commerce, security of personal and financial data of citizens, joint ventures, encourage working, estate investments
	People	ICT in education, smart work center, safety service, increase quality of life, data access
	Environment	Co2 reduction, green growth ,controlling pollution, sustainable urban solutions, clean, blue and green physical environment, waste minimization and recycling, enhancing biodiversity, climate green solutions
Soft Components	Mobility	Road situations, real time, road maintenance and consequent diversions, road pricing to reduce congestion, bike community, digital, enhancing public transport, electrical vehicles, digital devices along roads ,sustainable transport, traffic management.
	Built Environment	Free public Wi-Fi, smart meters and smart grids, efficient buildings, green roofs. Multi-story car parks ,green roofs and facades, digital sensors and smart meters, smart grids, broadband and smart energy network

Chapter 5

CONCLUSION

Cities nowadays occupy more than half of the total world population, where the places of social cohesion, financial, intellectual, and innovation centers. But cities create different challenges especially in term of environment, which emit three-quarters of CO₂ and consume 70% of energy production, generating large amounts of waste. Demographically, there are large numbers of young people who are facing unemployment in developing countries. In developed countries, the population grows older, has no ability of transport systems within the limits. Energy use and pollution are on rise, leading to an increase in the prices of services and the effects of the quality of life.

When the cities become smarter, they have opportunity to resolve these different challenges. Smart city provides eco-friendly approach to cope with climate change and makes management of sources more efficient; as well as increases the quality of life for its residents.

Despite the term of smart city is inconsistent terminology and until now has not been specifically defined, in other words, there is no standard definition of “smart city” whereas this term is used in different context, but depending on previous work along chapters of thesis we could say now:

A developed urban area that produces a sustainable economic development and creates an optimal place for people to live by increasing the quality of life, through highly enhancement of multiple key areas; governance, economy, people,

environment, mobility and built environment. Enhancement of these key areas can be achieved through human capital and infrastructure for information and communication technology.

This research developed a scientific approach to explain smart city concept, clarified the benefits of applying this model of cities, also suggested a new “array” of the dominant components of smart cities and which of those components are recommended and implemented in four ranked smarter cities in the world, this suggestion based on integration of previous classification of smart city components reaching to group these components into two main themes (Soft Components and Hard Components).

Depending on the analysis of case studies and literature review in the previous chapters, it is recommended to shift all “non-smart” cities toward smart city. Although the transition to a smart city is not trip and cannot be achieved overnight, but the first step is a determination to achieve this goal, then the stakeholders would to and draw a road map with collaboration of governments and companies, researchers, architects, designers and urban citizens.

This research may be serving as a reference for designers, architects, urban planners, researchers and policy-makers in the development of cities.

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