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Smart Cities: Survey

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ABSTRACT

A smart city is one that uses a smart system characterized by the interaction between infrastructure, capital, behaviors and cultures, achieved through their integration. From our survey of the smart city concept by reading recent papers in this field, we found no uniform concept of the smart city; some papers discussed it as a general case study, while others dealt with specific parts. This paper is a survey of a number of articles, which we divided into two categories:1-General case study, which covers the topic of smart city in a general framework, and 2-Specific case study, which covers the topic of the smart city from a specific detailed application, such as Traffic Management System, Smart Grid and Wireless Technology. The results of our research show that the information of communication technology (ICT) covers all areas on smart cities such as government facilities, buildings, traffic, electricity, health, water, and transport. Until now there is no unique definition for smart cities, most of researcher define the smart city form their needs or prospective.

Keywords: **information of communication technology (ICT), Wireless sensor network (WSN).**

1. Introduction

The proportion of world population in cities is more than 50%, and it is expected that this percentage will increase to 70% by 2050. The many problems in providing infrastructure and public services (Naphade, Banavar, Harrison, Paraszczak, & Morris, 2011) for the population in cities can be solved through investment in information of communication technology (ICT) and infrastructure technology. It is necessary to link the growing numbers of people with necessary services anywhere and anytime, and hence came the idea of creating a smart city project, which aims to organize daily life through building infrastructure with the use of networks.(Al-Hader, Rodzi, Sharif, & Ahmad, 2009b) Nowadays, information and communication technology is an essential part of urban development, and is necessary for all smart cities. Smart concepts include smart transit, smart people, economy, living and smart management to improve quality of life, and new infrastructure, with prudent management of natural resources through government involvement.(Schaffers et al., 2011)

A smart city is a self-contained town in terms of evolution of information and communication infrastructure technology. (Gil-Castineira et al., 2011) A modern city offers intelligent solutions and helps organize daily life thanks to sensors which receive data, information, references, and analysis and then retransmits them. Making cities smarter is usually achieved through the use of ICT-intensive solutions. In fact, ICT is already at the heart of many current models for urban development.

One advantage of smart cities is that pollution monitoring makes for an eco-friendly environment. The extensive use of ICT also empowers the development of essential services such as health, security, police and fire departments etc. A smart city can make our lives energy efficient. Wireless innovations can support public health, giving doctors access to medical records easily and at minimal cost. The main goals are automated diagnosis and health care for patients in dangerous situations. This will be implemented by sensor devices, which can monitor temperature, rate of breathing, etc. and provide a personal picture for diagnosis.(Vassilaras & Yovanof, 2010)

2. Background

Due to increasing population and poverty, failures of infrastructure during natural disasters have cost many lives and much property. A flexible infrastructure helps to reduce the effects of disasters. A smart city can use wireless technology to replace communications infrastructure destroyed or damaged at such times.

A smart city requires some basic components such as smart phones, networks, sensors to connect the people with mobile terminals, etc. ICT can be used in the home, workplace, and in public facilities. Its function is to manage the city more efficiently. The connected sensors will support the infrastructure such power grids, oil pipelines and vehicular movement.(Jungwoo, Songhoon, & Choonhwa, 2011)

Wireless networks connect computers and other devices using radio waves, with air as the medium. They offer some advantages such as flexibility, low cost, and high standard. There are different types such as local area network (LAN), metropolitan area network (MAN), wide area network (WAN), and mobile devices network. Wireless network connections are wireless fidelity (WIFI), IEEE802.11a/g/b, and g. World-wide inter-operability (WIMAX):IEEE802.16 is for microwave access. (Fragkiadakis, Askoxylakis, Tragos, & Verikoukis, 2011) Signals used in a wireless network are broadcast by radio and satellites (which send information all over the world).

WSN is a group of large numbers of heterogeneous sensor devices spread over a large area, linked by wireless media. The sensors collect information to monitor physical or environmental conditions such as temperature, sound, vibration, pressure, motion, and pollutants and pass their data through the network to a central location. Challenges in the use of WSN include energy, computation, communication, scalability, fault tolerance, and power consumption.

From our survey of the smart city concept by reading recent papers in this field, we found no uniform concept of the smart city; some papers discussed it as a general case study, while others dealt with specific parts such as : A-smart grid, B-smart meters, C-Intelligent Transportation system (ITS), D-smart home, E-smart water, F-medical care, G-smart food and other.

2.1 Smart Grid

There are different definitions of the smart grid: functional or technological. A common example is the digital electricity grid that collects and distributes information. It provides electricity from the supplier through bilateral technical direction. A smart grid is a flexible system that links people with technology and natural systems. It consists of an electric grid, a communications network, and hardware or software to monitor and control it. It can provide power, minimize cost and provide instant information. See Figure 1, below.

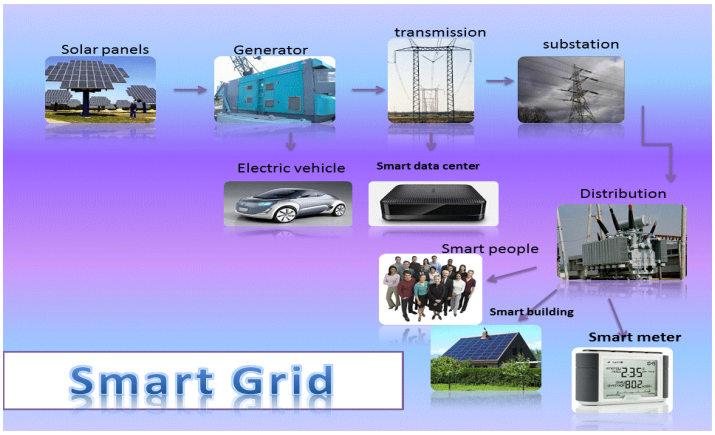

Fig.1. Smart Grid

2.2 Smart Meters

A smart meter system has benefits for the customer and the company. It consists of smart meters, communication infrastructure, and control devices. Smart meters can calculate electricity usage, and provide information to the company to regulate power and monitor and control devices.

2.3 Intelligent Transportation System

ITS uses modern techniques of communication and media technology in urban areas for the taxi system, mass rapid transit (MRT), light rail transit (LRT), electronic road pricing (ERP), road information management system (RIMS), traffic signal optimization system, electronic communication system, and automobile navigation systems to face many challenges in various means of transport. Smart transport systems contribute to the rational exploitation of existing infrastructure without resorting to the establishment of new facilities. The objective of ITS is:1-improve the economic productivity of current and future systems, 2-energy conservation and environmental protection, 3-improve the level of traffic safety 4-increase the prosperity of travelers, 5-increase the operational efficiency of the transportation system, 6-reduce commuting time and cost, and 7-predict the movement of traffic and events that may affect the future.

2.4 Smart Home

The papers reviewed had different views of the smart house. Some viewed the house in terms of its dependence on modern technology. However, we view the modern smart house as controlled by the occupant/owner. The smart house obeys the owner's wishes in terms of protection and comfort. Technologies that support the communication of the smart house with the owner are mobile, computer, and internet networks, whether the owner is inside or outside the home.

The goal of smart building is to satisfy both the owner and the occupant, and not everything that one customer requests is requested by another. One solution provided by a smart building is lighting control; an intelligent lighting system provides lighting everywhere so that the occupant never has to enter a dark room. Energy and temperature controls provide cooling or heating in the home. Security and safety are provided by temperature and movement sensors, which can also turn off lights and lock doors when you exit, and sound the alarm if intruders appear. Entry and exit is controlled by pass codes entered on a keypad.

2.5 Smart Water

A smart city uses a variety of techniques and systems that contribute to reducing water use. Poor management and suboptimal use of water have large negative consequences. We need to have smart systems to maintain our natural wealth through 1-monitoring and control of environmental water such as natural rainfall, surface water, groundwater, wastewater and agriculture water, 2-analysis and response to the data to improve the efficiency of use, which requires cooperation with all stakeholders, 3-ensuring the safety and health of the network and making sure ongoing maintenance is performed, 4-controlling pollution and strengthening the capacity to respond in an emergency, 5-using smart water meters that predict the population's consumption of water, 6-designing green spaces which help reduce evaporation, and 7-using local plants and trees which require little water.

2.6 Smart Health Care

Smart cities provide multiple solutions, but require cooperation among local hospitals and private networks for the exchange of the necessary information to increase efficiency for the treatment of patients and link with pharmacies to provide drugs quickly and easily. Special wireless access to emergency departments can help with medical emergencies by transmitting vital information. Automated diagnosis and health care can be provided for the patient in a dangerous situation. Sensor devices can be put on the patient's clothes or skin and information sent to the hospital. The devices can monitor temperature, rate of breathing, etc. in real time.

2.7 Smart Food

A smart food system consists of a tracking system which monitors the food supply, production, processing, transportation, and risk control. Another element is ensuring compliance with health and safety systems. An emergency system can provide early warning of food security problems.

3. General Case Study

In this section, we will discuss the articles included in the survey that cover the issue of the smart city in a more general sense. Technology has caused a sensation in the world. It has led to the creation of the first smart cities. The first smart city in South Korea is "ECO-U-CITY" aka Huaseong Dengtan. It was completed in 2008, and six more smart cities are being designed. South Korea developed Eco-U-City as a smart city with green technology for greater safety and comfort with less carbon emissions. An Integrated Service Management Platform (ISMP) system was created which consists of 3 layers: service, middle ware, and infrastructure.(Jungwoo, et al., 2011) See Figure 2, below.

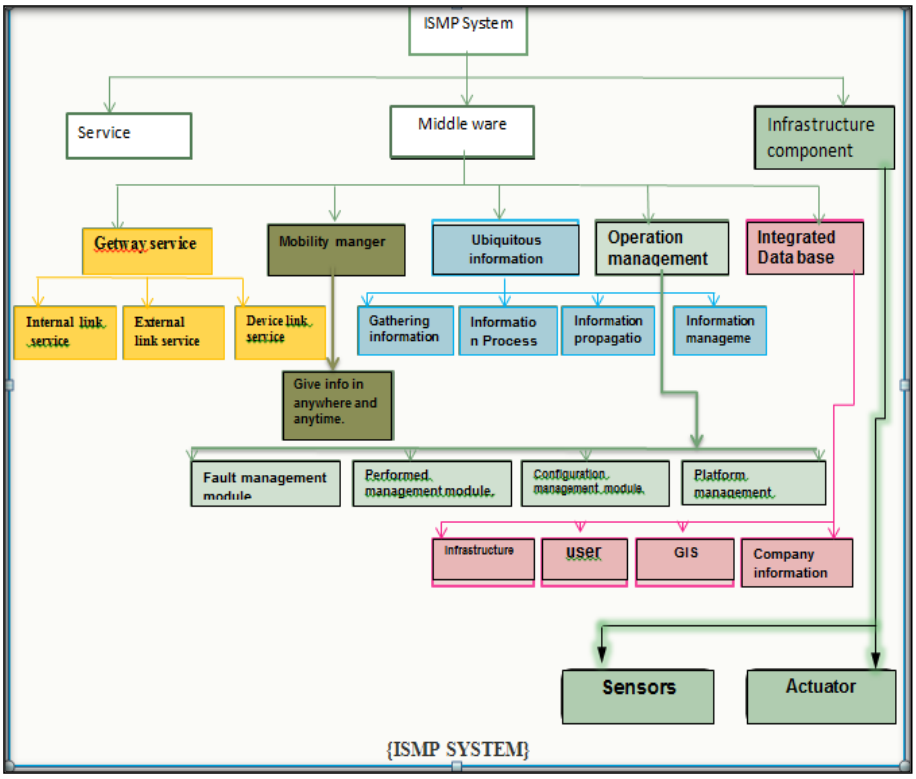

Fig.2. ISMP System

Despite an increase in projects and research to create smart cities, it is still difficult to provide cities with all the features, applications, and services required. Oulu University creates and coordinates the middle ware layer to connect the government with the people. Some advantages of the smart city are: promoting healthy life by eliminating obesity, diabetes, and heart problems. The wireless infrastructure in urban areas can help encourage people to exercise.(Gil-Castineira, et al., 2011)

In the last few years, the government has decided to provide a national project to implement smart infrastructure. The first step, which is based on maintaining wireless infrastructure by Enterprise Resource Planning (ERP), is replacing the old infrastructure with a new one. The smart city maintains a smart database resource, a smart building management

system, and a smart interface. The goal of this system is to improve operations and maintenance and reduce operating costs.(Al-Hader, Rodzi, Sharif, & Ahmad, 2009a)

City infrastructures have faced crises and severe pressure, due to increased demand for water, energy, transportation, health care, education, and safety. Migration and urban growth have caused these problems, and smart city technology can be the solution to meet the future needs of the citizenry this is sought by many countries such as the United States, Brazil, Denmark, South Korea, and others. However, still there are many obstacles and problems, whether technical, socioeconomic, or political, that must be faced. (Naphade, et al., 2011)

Smart cities are called by many names such as: e-city, digital city, information city, smart communication and digital communication. The main smart cities in the world are: Malta, Dubai internet city, Dubai media city, Dubai festival city and Kochi. Building a smart city improves the infrastructure and use network, contributes significantly to reducing administrative cost, and enhances the quality of services, because it provides initial guidance to improve operations and maintenance. The development of the smart city needs 1-infrastructure preparation, 2-building a database, and 3-building a management system.(Al-Hader, et al., 2009b)

A smart city consists of smart infrastructure, people, management, phone, transmissions, the internet, cloud computing and IOT to improve efficiency. Smart cities start with ICT, focusing on broadband infrastructure. However, the government must approve the development of the smart city, and there may be higher priorities. This paper presents some models such as a fire project that consisted of end users and researcher, an IEFIS project for utility management, and an ELLIOT project for service, transmission, and environment.(Schaffers, et al., 2011)

Although there are different definitions of smart cities, the objectives are clear and require the continuous development of information technology. Technology alone is not enough; we also need new cables, connections, and programmed sensors as well as advances in hardware. When the footprint is enabled, it can begin to provide service and interaction. In South Korea, smart cities have kept pace with development. (Helal, 2011)

Smart cities have to be smart in mobility, living, economy, environment, government, and the people. They must provide service anywhere and anytime. In disaster management, we need quick response to situations as well as risk management. For success in the workplace, we need cooperation on policies, experience, equipment, and employees; also, development by using grid and cloud technology. (Asimakopoulou & Bessis, 2011)

Cisco joined the Songdo project in 2009 and has invested US $47 million in order to make Songdo a smart city and the most wired in the world. This goal is expected to be achieved in 2018. The project is focused on buildings and has collaborated with developers to build its networking technology into new buildings. These buildings will include telepresence capabilities and many new technologies .This domestic offering is only the first step; Cisco aims to link energy, communications, traffic, and security systems into one smart network. (Strickland, 2011).

Smart cities rely on their existing infrastructure, with several improvements and modifications. “SOA technology" is used to build the information system in the smart city and improve the management of the system, increasing its speed and reliability in addition to safety. (Duravkin, 2010)

Smart cities need smart architecture. The Sofia project introduced the idea of the Interoperability Open Platform (IOP) which allows management and cooperation between heterogeneous sensors to monitor public places. IOP has been developed by Sofia Union, and the first version was Source forge. (Filipponi et al., 2010)

A modern hi-tech park in Wuhan is considered an urban complex that is multi-functional and ecological. Wuhan is a city that is high-tech and self-sufficient. It is an eco-smart city designed for exploring the future of the city. It is a natural and healthy environment and incubator of high culture, and expands the meaning of the modem hi-tech park. (Shidan & Siqi, 2011)

The aim is to develop an evaluation of smart cities based on ICT .by providing services that people need. The focus is on ICT services that people need, not just those that depend on ICT infrastructure. Taipei City clarified that government must provide an integrated infrastructure with ICT application and service. (Jin-Gu, Yu-Fan, Su-Yi, & Yu-Chia, 2011)

China has encouraged the transition to urbanism by improving public services and improving efficiency for transformation to the government model, enhancing economic development of the city. In 2008, a “digital plateau” was proposed; in 2009, more than ten provinces set goals to build a smart city. China focused on improving the construction of the city, industrial structure, and social development. To start the implementation strategy, a good plan is necessary, as well as knowledge of the importance of smart city construction. The reform measures that should support the construction of the smart city are 1- information security is a national issue, 2- strengthening the system of the smart city can control risks, and 3- the internet needs to be legislated. (Shi, 2011)

4. Specific Case Study

The "Eco-system" concept takes into consideration NANO-bots, found in computer devices, smart buildings and smart cities. NANO-bots are used in smart phones, cameras, smart objects and home robots. Though their use may threaten the environment, in the end, their usefulness is worth the risk. (Duval & Woo, 2010)

The objective was to create a platform with infrastructure depending on electricity, consisting of three layers: physical, data transfer and information flow. But there are some challenges to creating the platform. Smart cities are changing the economic system, the financial system and the social system on the basis of an infrastructure based on electricity and energy. The power system component of a smart city consists of smart buildings, smart meters, a smart grid and a transitional phase. (Lugaric, Krajcar, & Simic, 2010)

Smart city and information and communications technology (ICT) infrastructure can be maintained through the establishment of the data center dynamic metropolitan (MDDC), which is founded on the dynamic data center (DDC), and data vitalization technology. The main difference between DDC and MDDC is that the former focuses mainly on the hardware of building a data center while MDDC concentrates on the data itself. A new way to manage and protect proprietary data effectively in smart cities is the technique of digital watermarking. This involves the incorporation of information into digital signals (such as voice, pictures, and video) that is difficult to remove. The visual data usually carries a large amount of information, taken from satellite snapshots. The main properties of visual data are

high capacity and real-time and tight-coupling structure. (Chen, Fan, Xiong, Zhang, & Luo, 2010)

802.15.4 refers to wireless global connections, sensing and gathering information, and using this information in the smart city, using WSN . In China in 2009, "PAN wireless" represented the evaluation of the performance of IEEE. After field testing that measured the impact on the urban environment, they found that range transport was 200 meters in the open scenario and 40/60 in the heavy scenario and when the speed was 80 Km/h, the performance was not affected by movement of the transmitter and receiver. The most important factor in performance was the line of sight between sender and receiver losing the line of sight means there will be an intermittent connection. (Bingfeng, Qiao, Dong, & Lin, 2010)

Smart wireless sewer sensor networks can be made by using parasitic slot arrays that protect antennas. The important challenges the designers face in the sensor network is coverage with slot antennas that must achieve increased signal strength indication (RSSI). The result of the project is that the electronically steerable parasitic manhole cover antenna can be controlled by sensors with measurements that will improve the packet rate in urban environments. (Seongheon & Chappell, 2010)

The advent of technology and the existence of the internet have helped transform traditional cities to cities that are more impressive and interactive. By using digital screen technology working remotely via the internet, there is more interaction between the individual and the group; any surface can become a digital display, so space has become more vital. The existence of this type of interaction between people and screens should be taken into account in the design of multiple techniques depending on user interaction. The city wall in one of Helsinki's central pedestrian areas and the Berlin University of Arts Magical Mirrors temporary art project in 2006 are examples. (Kuikkaniemi et al., 2011)

The world will face in the future many disasters and problems, such as infrastructure, energy, resource renewing, and climate. Due to the development of technology and climate change, intelligent buildings and smart cities aim to reduce the use of fuel and energy.

Building Automation (BA) using smart technology will control temperature, ventilation, building access, etc. Structures must be built with smart technology in mind. Management can encourage the use of smart technology to cut costs and improve efficiency. (Bach, Wilhelmer, & Palensky, 2010)

The Sens city project provided a platform between "M2M" and the network to allow access to the web. Some of these services were smart metering and traffic and parking management. M2M system infrastructure consists of devices, sensors and actuators. A multi-agent organization using the MOISE framework for smart parking management helps drivers find parking spaces, and reduces traffic and pollution. (Persson, Picard, & Ramparany, 2011)

Adam Dunke is one of the top 35 innovators in the last 35 years in the field of micro-sized IP-based technology. He discussed challenges in managing the growth of a city, observing water supply and energy, and ensuring safety. He also discussed factors that influenced the development of an IP-based sensor network such as that the people did not have awareness and network skills; sensor networks working on wireless networks require special knowledge. (Vasseur & Dunkels, 2010)

The conference in Berlin, Germany in April 2009 talks about mobile wireless middleware by ICST, operating systems and applications. The scope is design, implementation,

deployment, and evaluation of application middle ware operating systems. A few papers discussed the possibility of implementing an autonomous navigation algorithm by phone;, others used the widget concept to rapidly develop an IMS Client application. (Bonnin & Magedanz, 2010)

When an accident happens, the connections in the network are disabled, and it is important to help people in danger, using audio and video technology such as push-to-talk, real-time text messaging, broadcast/multitasking, "UMTC" satellite communication , terrestrial trucked radio, Wifi, and Wimax. ERCN infrastructure is perfect for emergency and disaster events; it connects different types of networks by "WMN ".(Fragkiadakis, et al., 2011)

Urban communities have had many problems that need to be resolved through infrastructure investment and information and communication technologies. A proposed design is the Mobile system for directing drivers in smart cities, which aims to supply important information that helps in decision–making and for mobility purposes. Its applications include directions and guidance about electric vehicles, traffic, battery charging stations, and city mobility infrastructure. The design is in the initial stages, and there are difficulties that need to be addressed. (Ferreira & Afonso, 2011)

U-city is a smart city that connects information technology with urban engineering. It uses the SNMP protocol that is widely used in the internet, but is a static topology and uses a small number of devices, so UNMS takes care of bandwidth to send disaster–related information for mobile users through an ad-hoc network. It uses the Linux system to reduce the pressure on the main server. (Jin Goo, Ju Wook, Chang Ho, & Yong Woo, 2011)

The objective of the project, "Seoul ubiquitous smart city" is to find a way to measure temperature, humidity and noise level in Seoul. The problem is that they need to control the urban areas by installing a large number of sensors everywhere which must be connected to a wireless network. To address this problem, the Moving Sensor Unit (MSU) is used. However, some changes and improvements, under implementation, are still needed. (Phil Doo & Yong Woo, 2009)

http://www.smart-city.com.au is the local government website which contributed to reducing the local internet bottleneck. The database of information remains constant but changes are carried out by the interpreter. The bottleneck can be removed in two ways: 1- brute force, 2- bypass. (Walker & Bryan, 2000).

5. Conclusion

Technology has made many fantasies about the lifestyle of the future a reality. The smart city is just one of the technical applications that have done this. The idea of smart cities is applied to multiple images in many parts of the world such as the United States, Brazil, Denmark, South Korea, Malta, Songdo, China, Taiwan and others. These cities will make a qualitative leap in the quality of life. Smart cities are built to suit the needs and potential of the modern city. Some of the nomenclature used is the "smart" city, digital city, information city, smart communication, and digital communication.

The smart city depends on building a smart infrastructure based on a wireless sensor network (WSN) which represents the backbone of the city depending on the global network.

WSN still faces many problems; the Moving Sensor Unit (MSU) been established as a solution to address one of these problems.

An ICT system is much more sophisticated and complex; there must be integration of data from different sources, and the cities must have the ability to respond "smart" for different requirements of daily living; for example, the fire system sends an urgent communication to the fire station nearest the site of the fire. Nearby hospitals are alerted to the arrival of patients. The entire system relates to the central system for administration of the city.

ICT covers all areas such as government facilities, buildings, traffic, electricity, health, water, and transport. The concept of the smart city is still in the initial stages and we cannot yet prove the efficiency of "smart" cities because the concept has been applied only in small areas. People should be receptive to the use of this technology which is characterized by its interaction with the user.

6. Future Work

This work will be continued by surveying these publish papers on smart cities and reformation characteristics for sensors and routing protocols following with factors such as: power efficiency, Quality of service (QoS), speed of transmit data, coverage, type of sensors, data storage, security for data transfer, cost of implementation, type of platform and processor, size and weight of sensors,…etc.

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