TOWARDS SUSTAINABILITY: SMART CITIES IN THE EGYPTIAN ENVIRONMENT
How much Smart to be Smart?

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Abstract

Egypt, as a developing country, is facing many environmental, social, and economic issues in its cities. Those issues are the challenges for The Egyptian government to achieve sustainability and improve inhabitants' quality of life in the future city's vision of the nation. The fourth cyber-physical revolution and the growing exponential innovations of information and communications technologies (ICT) were the catalysts for the Egyptian stakeholders to target the sustainable smart city concept for the new future Egyptian cities generation.

The research aims to characterize the smart concept for the Egyptian environment by proposing an ICT architecture for the smart city model within the Egyptian cities and highlight the innovative ICT that will affect the future performance of such smart cities. The research attempts also to identify the main Egyptian smart initiatives that would offer appropriate sustainable solutions and improve the quality of life of the Egyptian inhabitants.

To achieve the research objectives the innovative ICT installation requirements were studied to propose a compatible ICT architecture for the future city structure and an interview for experts was statistically analyzed to determine the Smart city initiatives and smart component systems prioritization for the future generation Egyptian cities.

The research concluded that there are no unique standards of the city smartness concept and a community requirements study must be considered before deciding the smart initiatives and the smart system's components to be installed.

The research determines that nowadays mobility, infrastructure, and governance are the main smart initiatives of smartness for the Egyptian cities.

Keywords: Smart City, Information and Communication technologies, ICT architecture, Smart city initiatives

1. Introduction

Egypt has become the 13th most populated country in the world with surpassed 100 million population, but only seven percent of Egypt’s area is currently fit for occupancy (GOPP, 2014). Recently, the existing Egyptian cities have been undergoing rapid urbanization and industrialization associated with a wide range of problems and impacts on the environment and in the process of the city urban management and development.

In this respect, sustainability has been the most trending issue worldwide and by the Egyptian national policy to cope with such urban and environment problems. This has led the Egyptian National strategy 2052 to target new sustainable urban communities to manage with such problems and to face the population increment and increase the occupancy area to fourteen percent by the year 2052 (GOPP, 2014).

The Egyptian Ministry of Housing, Utilities and Urban Development announced the construction of twenty new future fourth-generation cities with a total area of

580,000 acres to accommodate 30 million citizens (GOPP, 2014). One of the most glaring objective of this future cities is to enhance the citizens' quality of life and to contribute on the growing population challenge with satisfying the citizen's fundamental needs (Lopes & Oliveira, 2017). The Egyptian government attempts to achieve two main objectives on the future cities of providing people with high quality of access to energy, water, food, transportation, education, healthcare, governmental services and conserving the environment status and realize sustainability (Batty, 2013). The government believes the achievement of those objectives will be through the application of the new smart city concept for the future fourth-generation cities in Egypt (GOPP, 2014).

There is no commonly conventional definition to call a city a smart city (Lopes & Oliveira, 2017). The major definitions focus on the use of Information and Communications Technologies (ICT), while general definitions take an approach of city planning (Batty, 2013). On the other hand, an understanding of the smart city components and its application on the different sectors are not well defined in the Egyptian environment.

2. Objective

The main research goal is to characterize the smart city for the Egyptian environment by the achievement of two objectives:

The first objective to propose an ICT architecture for the smart city model within the Egyptian cities and emphasizing the new ICT that it will affect the future performance of such smart cities.

The second objective to identify the main Egyptian smart initiatives that would offer appropriate sustainable solutions and improve the quality of life of the Egyptian inhabitants. To reach the two objectives, the research is organized on the next sections as follows:

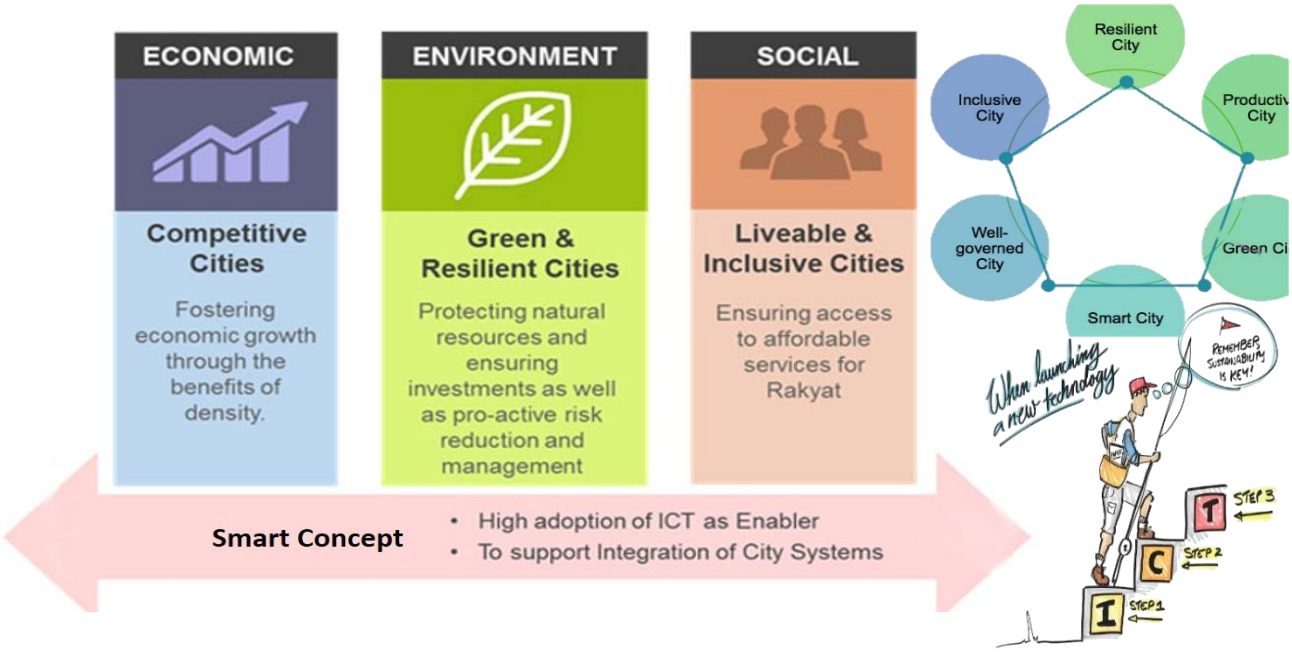
- The smart city and sustainability
- Introduction to the ICT as the backbone of the smart city model
- The proposed ICT architecture of the smart city in the Egyptian environment
- Smart city initiatives for the Egyptian environment

3. Smart cities and sustainability

A sustainable city is a city that has comprised the environmental, social and economic goals for better quality of life achievement of residents which is commonly measured as self-reported happiness (Phadtare & IndajeetJadhav, 2017). Different sustainable city has been initiatives depend on the goals and perspectives focused on such as green city, resilience city, zero carbon city, etc.

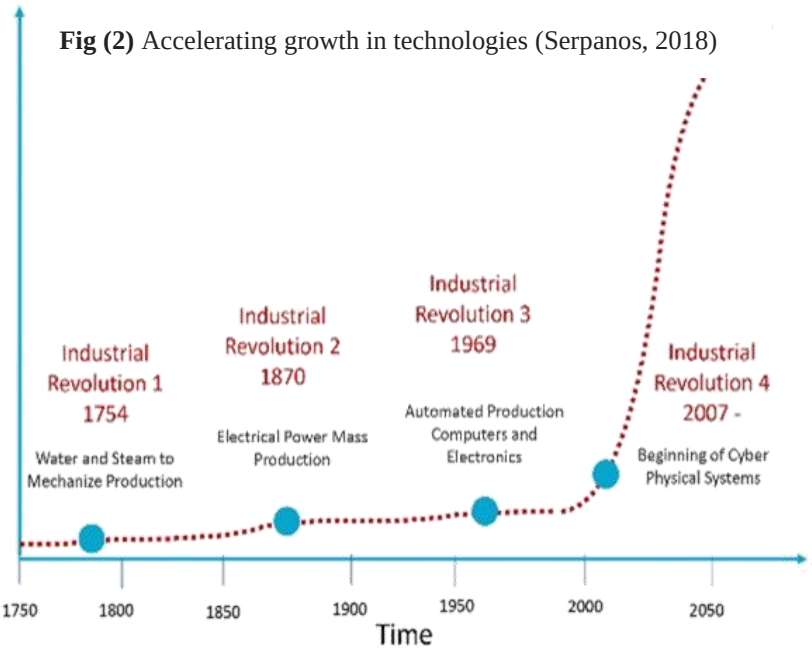
The smart concept is a broad term for the use of ICT to manage a city's services, infrastructure and facilities (Chourabi , Nam, Walker , & Gil-Garcia, Jan. 2012). The smart city concept is to use ICT to improve quality of life of residents by enhancing the city performance towards increase city level of sustainability (Stokes, et al., November 2015), figure (1). The smart concept might be applied to any type of sustainable cities initiatives to help the sustainable city to achieve its sustainable goals and increase quality of life.

Fig (1) Smart concept of sustainable cities (Phadtare & IndajeetJadhav, 2017).



Although different researches have defined smart sustainable city, the research found that the Smart Sustainable city might be defined as "an innovative city that uses information and communication technologies (ICT) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects".

Fig (2) Accelerating growth in technologies (Serpanos, 2018)



4. ICT and Smart cities

The Fourth Industrial Revolution (IR) is the fourth major industrial era since the initial IR of the 18th century (Serpanos, 2018). This fourth revolution is referred as cyber-physical systems where it is characterized by technologies that is overlapping the boundaries between the physical, digital, and biological spheres (S & B, 2017).

The cyber physical systems concept is to integrate sensing, computation, control and networking into physical objects and infrastructure, connecting them to the internet and to each other (Serpanos, 2018).

Just as the Internet transformed the way people interact with information, cyber-physical systems will transform the way people interact with electronic and digital systems. Cyber physical systems (S & B, 2017) are nowadays real and have the potential to reform our world with more reactive, accurate, consistent and efficient systems, enabling a revolution of "smart" devices and systems from smart vehicles to smart grids, collectively giving rise to smart cities that can address some of the most challenging national priorities.

The cyber-physical revolution will change how we live, work, and communicate. It's restructuring services provider of government, education, healthcare, and commerce and almost every aspect of life. In the future, it can also change the things we value, and the way we value them. It can change our consumption patterns, sense of privacy, relationships, our opportunities, and our identities as it changes the physical and virtual worlds we live (Jamaludin & Rohani, 2018).

Information and communication technologies will improve the lives of billions of people. Through increasingly powerful computing devices and networks, digital services, and mobile devices, this can become a reality for people around the world, including those in underdeveloped countries. Advancements and innovations in ICT are growing exponentially and become more advanced. Despite all these advancements it may not feel like these technologies are growing because we look at the world in a day perspective once a new technology has emerged we quickly take it for granted and we feel that it has been around all along (Yeh, September 2017).

ICT infrastructure is the basis of a smart city comprises high speed wired and wireless network connectivity, high end data centers, physical space enrichment with smart devices, sensors, actuators and much more. The E-governance will facilitate the development of strategic connections between various departments of public sector organization which will formulate the policies, rules and legislations to improve the performance of government organizations and offer potential benefits to citizens.

ICT is the backbone of smart cities and influence the success of smart city systems. Without it, the smart city systems will not succeed to achieve its targets. Consequently, ICT infrastructure design for smart cities must itself be smart and must be designed in a way to provide scalability, robustness and flexibility.

5. Proposed ICT Architecture of smart cities

The abstraction of cities are highly complex. The system analyst of the smart city with respect to the ICT design is difficult due to the numerous city objects with different behavior and properties (Bawany & Shamsi, 2015). City comprise people, communities, buildings, roads, services, etc. Managing complexity for city system is challenging. The research propose an architecture structure for smart cities based on object oriented approach of computer sciences.

Reviewing international smart city architecture from literature and the existing situation of ICT in Egyptian environment. The research proposed an ICT architecture of smart city contains six main layer as shown in figure (1):

a. Smart city Objects layer

b. Data acquisition layer

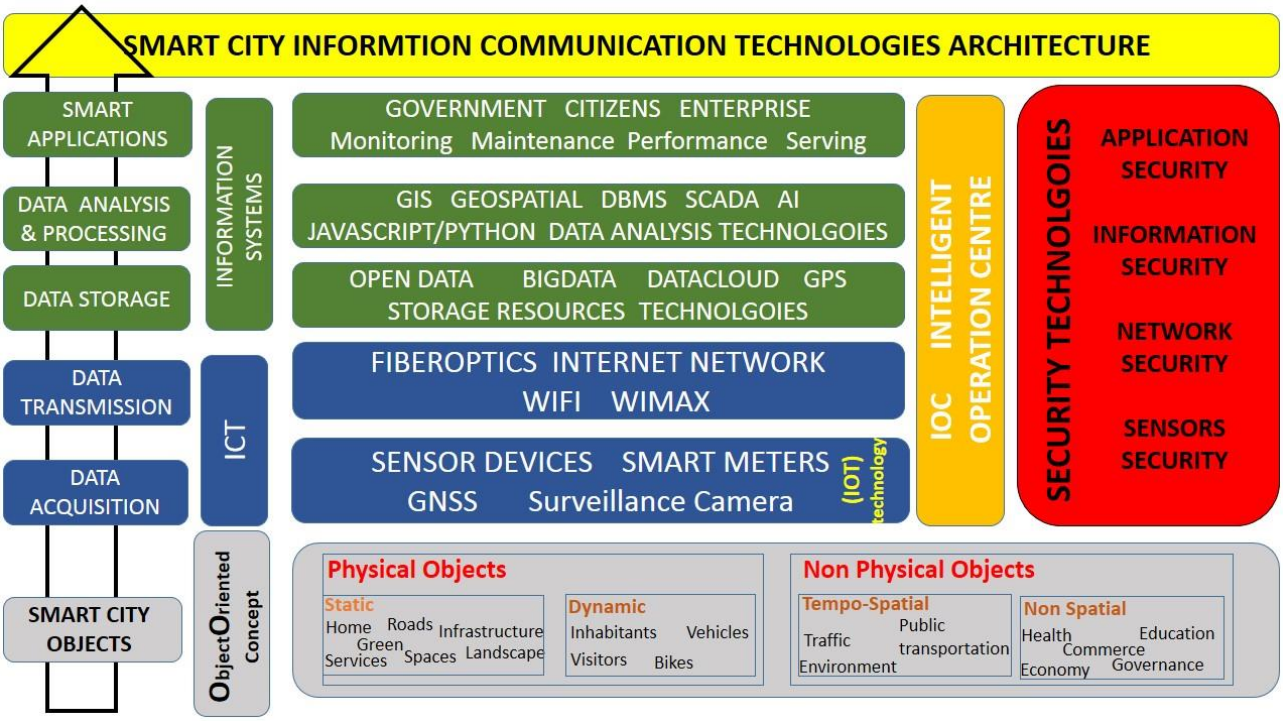
c. Data transmission Layer

d. Data Management layer (Storage and analysis/processing)

e. Smart application layer

f. Intelligent operation, data centers and data security layer

Fig (3) Smart City ICT infrastructure architecture (Source: Author)



5.1. Smart city objects abstraction layer

The proposed ICT architecture begin with an abstraction of the city objects to simulate the functions of the cities within an information system. The architecture is followed by the ICT infrastructure layers which form the foundation of a smart city.

The ICT architecture structure identifies city objects regarding the information type, communication technologies, the behavior and the characteristics of these objects. The research proposed two main objects class:

-Physical Objects: which can be defined as the identifiable collection of matter or body objects like parcels, buildings, roads. Those physical objects can be classified into static objects where their location are fixed and well known and dynamic objects where coordinates and time will be the main variables for their real time behavior like residents, vehicles, etc.

-Nonphysical Objects (City activities): which are object that does not have a bodies or/and city activities related and processed on the physical objects like traffic, city services (economy, health, education, etc.).The nonphysical objects can be classified into a tempo-spatial class where activities are characterized by their location and behavior and the second class are the qualitative activities and which cannot be related to a spatial distributions like government decisions, etc.

5.2. Data acquisition layer

Data acquisition of the ICT encloses mainly different smart meters and sensors types at every end node of city objects, which provide the ICT system with the information to determine behavior, performance of smart city objects.

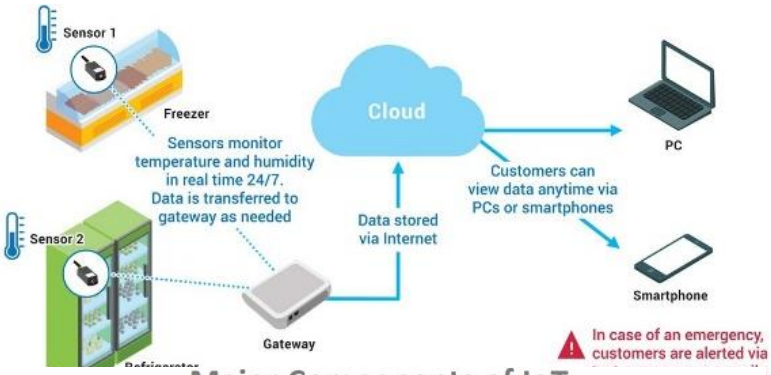
Smart Sensors use built-in computing resources and detection technologies to perform certain functions when it detects real world inputs (such as pressure, temperature, movement, humidity, energy and water consumption, water quality, seal level rise, etc.). Smart sensors use built-in computing resources and built-in wired/wireless data and internet of things (IOT) transmission technologies to filter, analyze collected data and sending it to the central platform where it can be processed (Yong , et al., 2018).

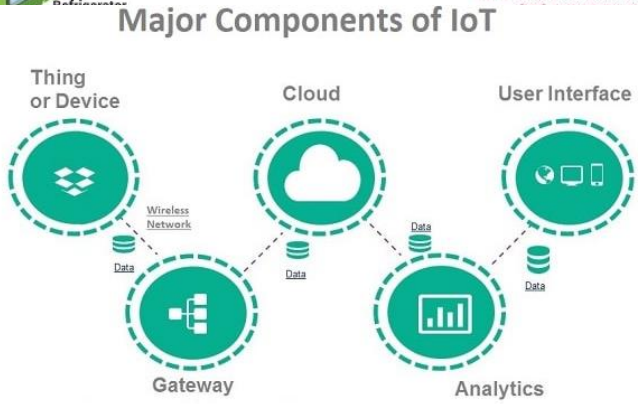
In addition, for dynamic and spatial city objects, the Global Navigation Satellite Systems (GNSS) will be accompanied with the different smart sensors. Increasingly, satellite data is becoming a fundamental component of smart cities and an essential tool for city management and governance. Detecting location and time of moving objects within a smart city, and tracking them, is a crucial object information to monitoring and predicting their real time locations, trajectories and behaviors.

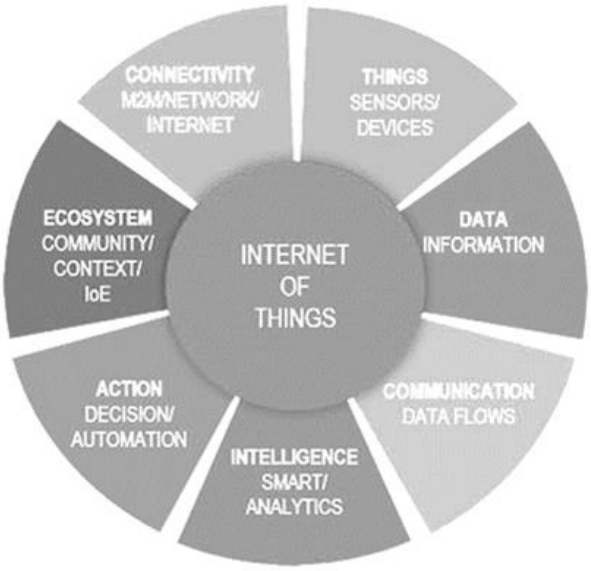
- **Internet of Things IOT**

Internet of things (IOT) is one of the innovative technology revolution which make smart city become in reality. The IOT technology enable the Internet to reach out into objects of the real world of physical objects. The IOT is a system of connected objects or things over the internet such as sensors, surveillance cameras, mobile, computers, vehicles, animals or people. Each object will be provided with unique identifiers and the ability to interact and transfer data over the internet network without requiring human-to-human or human-to-computer interaction (Liu, 2017).

Fig (4) Internet of Things, IOT (Liu, 2017)







behavior and activities within the smart city. With 50 to 100 billion things expected to be connected to the Internet by 2020, we are now experiencing a paradigm shift in which everyday city objects become interconnected and smart (Bibri, 2018).

IOT will help the achievement of smart city sustainability and resident's quality of life. Such technology will improve the smart city capabilities to monitor and improve city performance by solving real-life everyday challenges of objects within smart city (Kanga & Choo, 2018).

5.3. Data transmission Layer

Over the past few years, communication technology innovations have introduced as a widely recognized trend and are expected to play a crucial role in terms of providing connectivity in smart cities (Czamanski & Broitman, 2017). Two main types Communication technology are available for data transmission: Wired and Wireless network.

The wired network is the transmission of data over a wire-based communication technology. Most of the smart city networks today rely on the use of fiber-optic communication technology where it has the capability of accommodating far more signals than the older copper wiring, while still maintaining the signal strength over long distances (Bhoyara, Sahareb, Dhoka , Deshmukh, & Deshmukha, 2019).

There are two types of fiber optics: Single mode fiber (SMF) and multi-mode fiber (MMF). SMF provides higher transmission rate and up to 50 times more distance than multimode fiber. SMF can reach to 80 km distance with a transmission rate of 20Gbps, or maximum 40 km with 100Gbps transmission rate (where10 Gbps can transmit 1000 books/seconds or 6 high -definition TV HDTV channels) (Macioleka & Bestab, 2018).

Wireless technologies such as WiFi, ZigBee, Bluetooth, WiMax, 4G or LTE have presented themselves as solutions to the communication needs of smart city initiatives specially in transforming existing cities to smart cities and in low income districts where streets are too narrow and no infrastructure. The different wireless communication technologies and their characteristics are shown in table (1) (Dener & Bostancıoğlu, 2015).

Table (1) Wireless communication technologies (Dener & Bostancıoğlu, 2015)

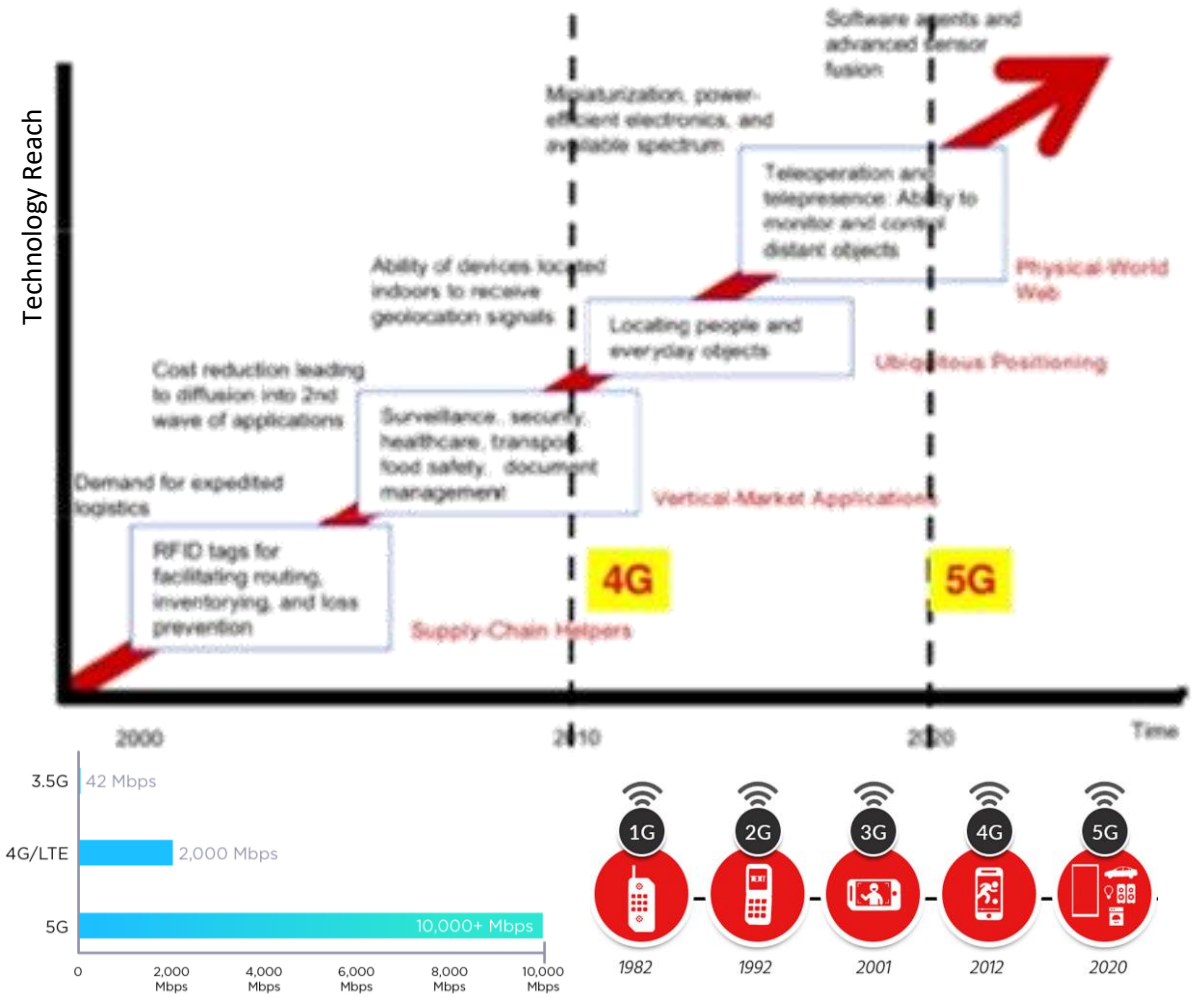
Communication technology	Standard/ governing bodies	Frequency	Range (approximately)	Data rates	Topology
Bluetooth	IEEE 802.15.1	2.4 GHz	1–100 m	1 Mb/s	Point-to-point
Z-Wave	–	900 MHz	100 m	9.6–100 kb/s	Star, cluster, mesh
ZigBee	IEEE 802.15.4	2.4 GHz	10–20 m	25 0kb/s	Mesh
LoRaWAN	LoRa Alliance	867–869 MHz (Euorpe)	2–5 km	290 b/s–50 kb/s	Star
WiFi	IEEE 802.11 (a/b/g/n)	2.4 GHz, 3.6 GHz, 4.9 GHz, 5 GHz, 5.9 GHz	100 m	1–5 4Mb/s	Star
WiMAX	3GPP	3.5 GHz	50 km	75 Mb/s	Point-to-multipoint, mesh
LTE	3GPP	2.5 GHz, 5 GHz, 10 GHz	30 km	30 0Mb/s(DL), 75 Mb/s(UL)	Star
LTE-A	3GPP	2.5 GHz, 5 GHz, 10 GHz, 15 GHz, 20 GHz	30Km	1Gb(DL), 500Mb/s(UL)	Point-to-point

Nowadays, the most popular types of internet access connections these days are the third generation 3G and fourth generation Wi-Fi.

- **5G WIRELESS COMMUNICATION TECHNOLOGY**

5G is the future fifth generation of wireless technologies and it will be faster than 4G and it will be 2020. 5G is the latest generation of cellular mobile communications. 5G performance targets high data rate, reduced latency, energy saving, cost reduction, higher system capacity, and massive device connectivity and which make it the catalyst for IOT systems figure(2). The transmission rate are supposed to achieve 1 to 20Gbps compared to the 4G standards which are 100Mbps up to 1Gbps (Al-Turjman, 2019).

Figure (5) 5G Wireless technology (Al-Turjman, 2019)



Due to the IOT and the smart concept in all sectors, it is expected that 25 billion "things" will be connected to the internet by the year 2020 considering 4.9 billion devices were connected in 2015 with a 400% growth rate in five years and we expect higher rate for next 10 and 50 years (Li, Xu, & Zhaof, 2018).

The Internet Protocol version 6 (IPv6) technology which provides the unique, numerical IP addresses necessary for Internet-enabled devices to communicate has

been developed for more than two decades. It was born to cope with the tremendous number of things will be connected to the network with the inevitable end to the smart deployment model and communication technologies.

IPv6 utilizes 128-bit addresses supporting 2^128 of 340 trillion trillion trillion billion IP addresses for end users instead of the 32bit address used by the existing IPv4 which supports around 4.29 billion IP addresses.

IPv6 technology is 20 times data transmission rate faster and compatible with the IOT technologies and the mobility objects where it has the ability to connect devices to each other at any time, in any location, allowing them to communicate easily with each other preserving same singular IP address for their device while communicating across different networks during mobility (Li, Xu, & Zhaof, 2018).

5.4. Data Management (Storage and Analysis)

The effectiveness of smart city depends on how well the ICT can store, analyze, share and manage the vast amount of data being generated by city sensors of objects. Thus can be proved by the new data volume units after the terabyte which has been published of Petabyte (PB), Exabyte (EB), Zettabyte (ZB) and Yottabyte (YB). Without the ability to manage such vital information in real time the smart capabilities of a city and its infrastructure will not be effective.

There are huge requirements and significance for innovations of information technologies to manage the huge data volume expected from the architecture of the smart city with respect to storage, processing and analyzing techniques of collected different types of data for smart city objects.

The innovation technologies involves the use of advanced database management systems (DBMS) and the technologies tools and techniques of manage obtained from different sources in different sizes. New technologies have been raised to cope with such data characteristics such as Big Data, Cloud Computing and new Geographic Information Systems paradigm to cope with spatial and temporal data and to handle and store real time objects data.

- **BIG DATA TECHNOLOGIES**

The Big data concept is a non-traditional strategies and technologies needed to store, organize and process large datasets and which exceeds the computing power or storage of a single computer systems. There is no a specific definition of big data but it is information technology concerning handle large datasets. Gartner's Doug Laney defined the Big Data technology by the "three Vs of big data": Data Volume, Data Velocity and Data Variety (Osman, 2019).

Fig (6) Big Data s technology characteristic (Osman, 2019)

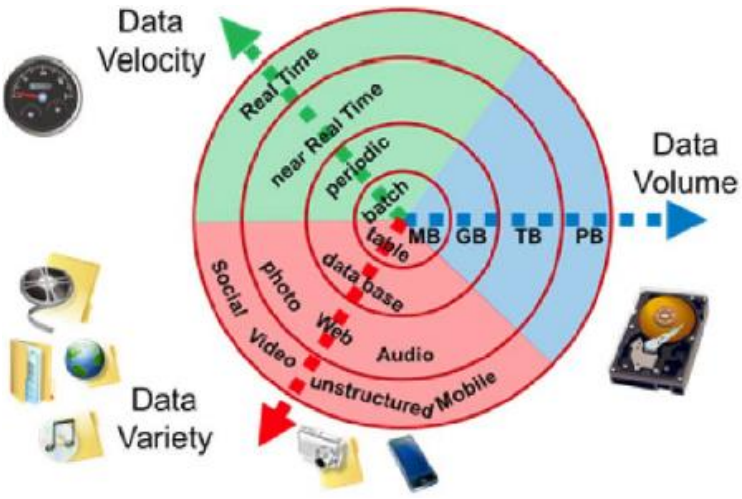
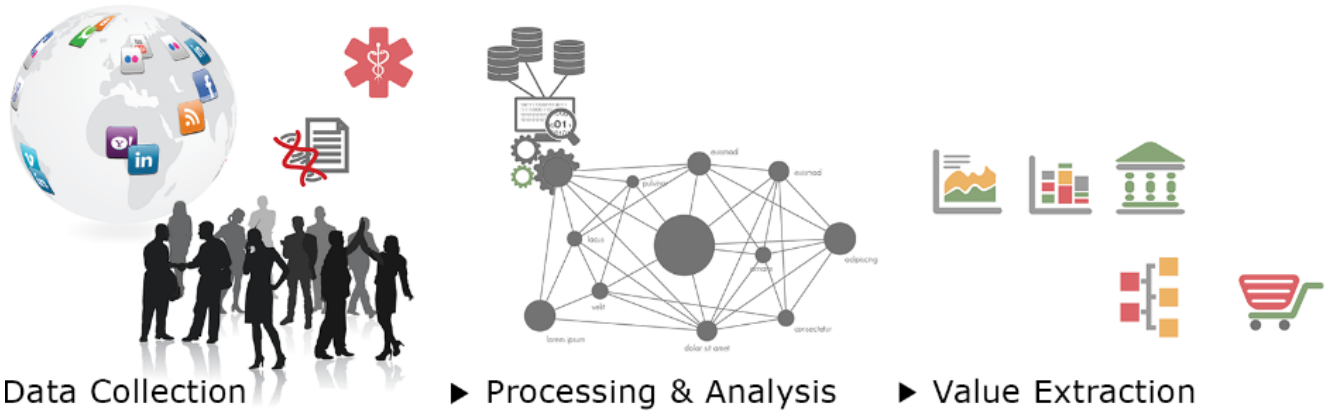


Fig (7) Big Data technology use (Osman, 2019)

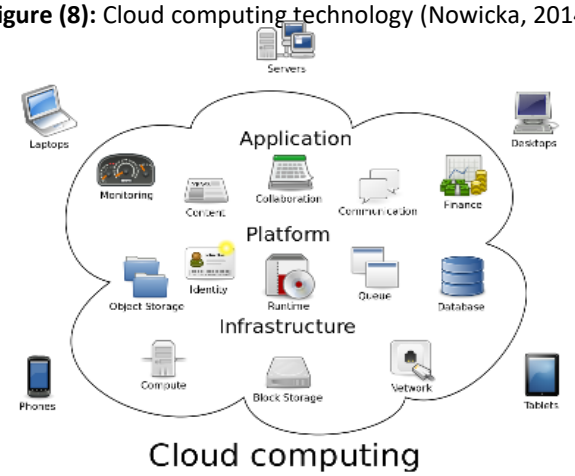


- **CLOUD COMPUTING TECHNOLOGIES**

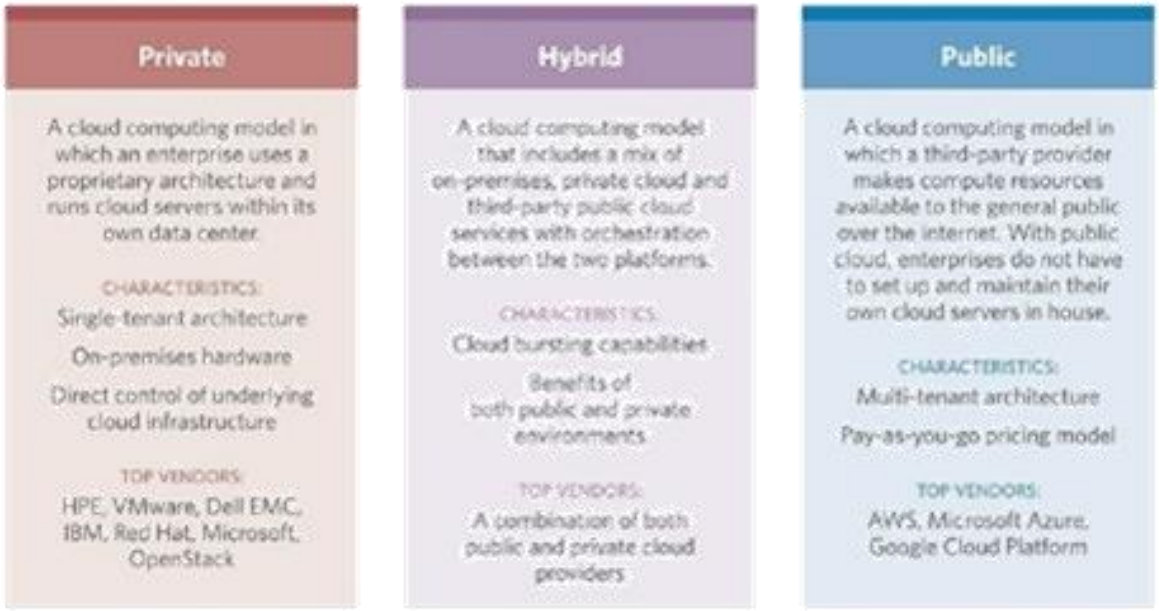
Cloud computing technology is a kind of outsourcing of computer systems. Users are able to access software and applications from wherever they are; the computer programs are being hosted by an outside party and reside in the cloud and their location is irrelevant for the users (Nowicka, 2014). This means that users do not have to worry about things such as storage capacity, software, updating, backup, security, hardware/software maintenance and power, they can simply enjoy the end result.

The Cloud computing technology will be an important components of the ICT architecture of smart city. Cloud computing offer three level of services: Software, Platform and Infrastructure services depends on the targeting users (Nowicka, 2014). The cloud computing system has three types for deployment: Public, Private and Hybrid depends on the data type and its use as well as the level of security and the smart city applications of sector information.

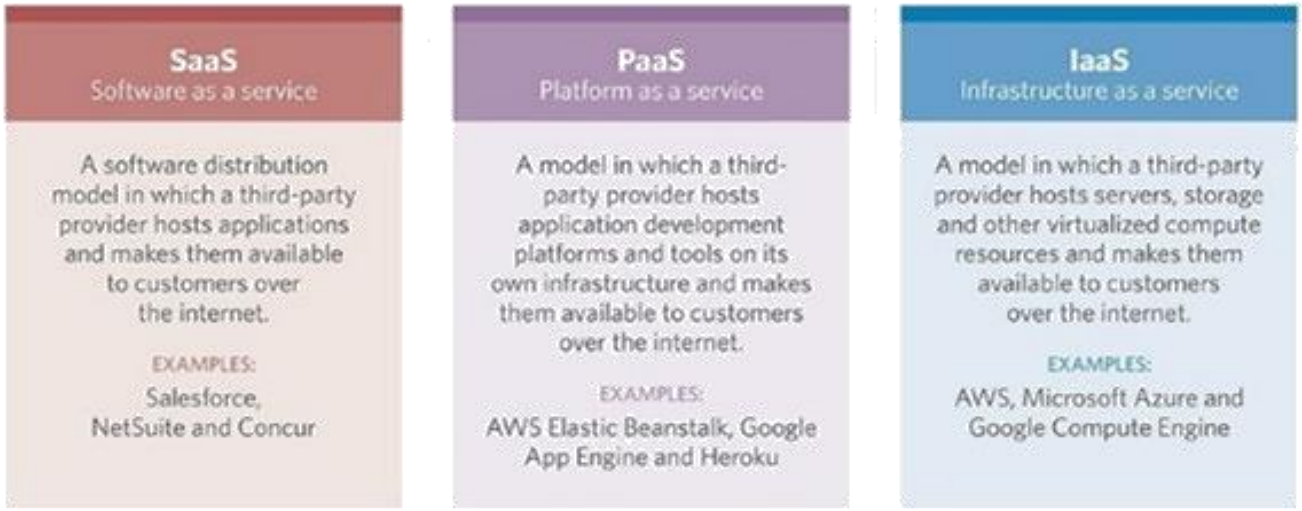
Figure (8): Cloud computing technology (Nowicka, 2014)



Cloud computing deployment models



Cloud Computing Service Categories



- **ADVANCED GIS AND DBMS**

The smart city concept aims at emerging a comprehensive information system that uses temporal and geospatial data to enhance the understanding of complex urban systems. The smart city concept also aims to achieve an interconnected, shared systems over a digital network that involves stakeholders and users for different city sectors.

To achieve such system smart city will depends mainly on new database management systems paradigm and the introduction of object-oriented data model which will allow the 'real world' to be modeled more closely. The object oriented concept which encapsulates both state and behavior, will be more natural and realistic representation of the urban systems objects complexity. Unlike traditional databases (such as hierarchical, network or relational), the object oriented database are capable of storing different data types.

Smart city includes hundreds of different real-time data streams accompanied with GNSS real time location data for smart city dynamic and static objects. Such real time detection objects introduce the spatial-temporal information technologies (Aina, 2017).

Geographic Information systems (GIS) are essential systems for the operational of smart city. New web based GIS technologies were borne such GIS server, GIS portal, Web applications, Dashboard, etc. The power of GIS spatial analysis and the advantages of the interactive GIS graphic environment allows the 4D GIS analysis and visualization of smart city objects and their IOT sensors more efficiency.

- **ARTIFICIAL INTELLIGENCE**

Smart cities are based on different dynamic and static objects and of intelligent sensors. Data flow from those objects and sensors is pulled instantaneous with everyday aspects of city life. Artificial intelligence (AI) technologies will be the platform on smart city to handle such data flow for every aspect of life which cannot be done by humans.

AI is the simulation of human intelligence processes by machines, especially computer systems (Aina, 2017). These processes include learning (the acquisition of information and rules for using the information), reasoning (using rules to reach approximate or definite conclusions), awareness and automated-decision (Allam & Dhunny, 2019).

The role of AI within smart city systems is to collect, filter, monitor, analyze, predict, awareness, make decisions and take action of the simultaneous information of the smart city objects. AI technologies will monitor and manage urban systems and provide guidance and recommendations for better decision-making, which will in turn make cities more sustainable.

5.5. Smart City Applications

It is clear that the spectrum of smart city application areas is very wide in the different sectors of urban systems, environment, economic, etc. The provision of real-time information about smart city components is important for running different helpful applications and services and will help for improve the smart city performance and the residents quality of life towards a sustainable environment.

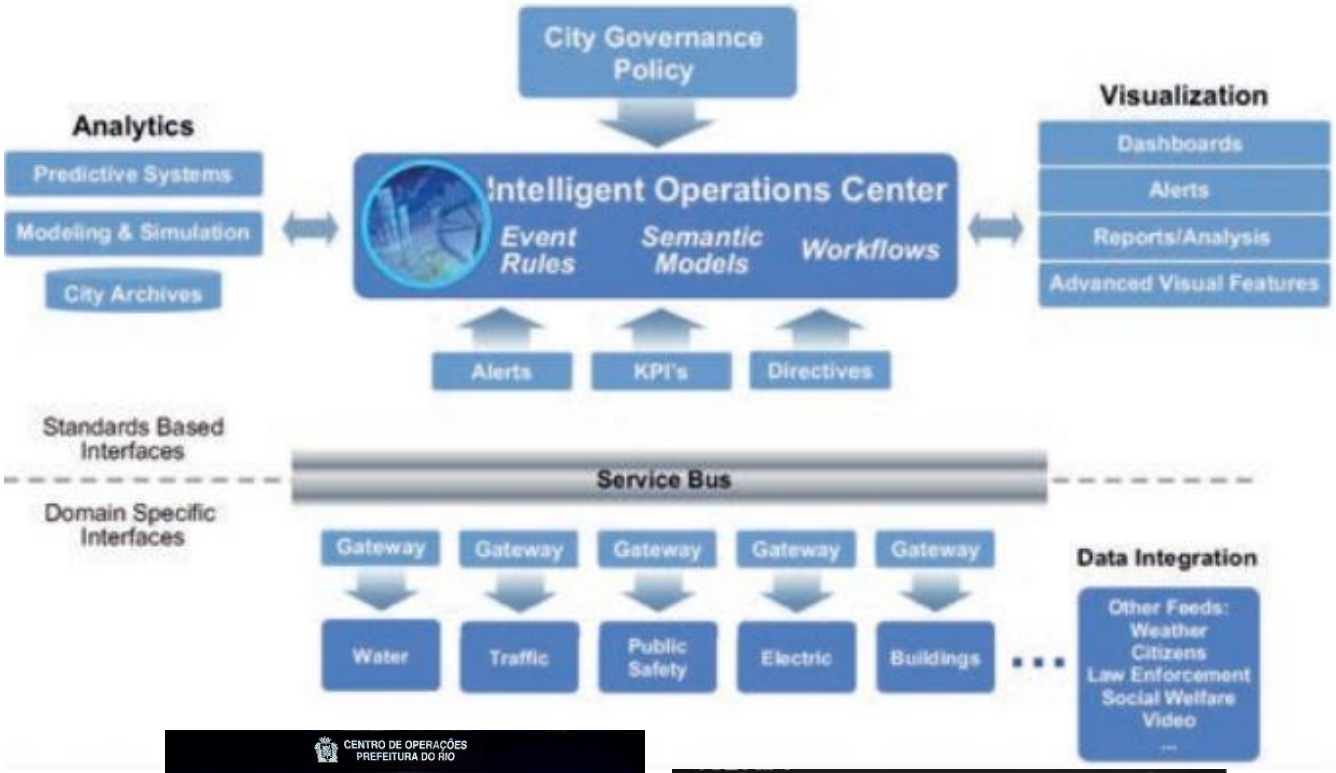
The smart city applications are the final products of all ICT components and the measurement gadget of smartness for stakeholders and users. Such smart applications will allow stakeholders and city users to access wide online services, with portals for basic information, residents services, business, traffic and public transportation and tourism, all based on an interconnected and common network infrastructure. Smart applications are sustainable due to their flexibility characteristics of developed new one, improving and updating existing applications. Smart cities are deploying online services in different city sectors such as smart buildings, smart health. Smart education, smart economy, smart commerce, smart environment, smart energy, smart water, smart sewage, smart transportation and traffic, smart government, etc.

5.6. Intelligent Operating Centers (IOC) , Data Centers (DC) and security technologies of smart cities

The concept of smart cities those whose physical and social networks are linked into a common framework based on advanced Information and Communication Technologies. The operational of smart city in reality with its scale exponentially, management presents a key challenge

DC and IOC are new born land uses in smart cities. They can be centralized or distributed in different smart districts. Both are at the heart of smart city system offering a unified real-time operational and monitoring all smart city information, data, assets and services, facilitating rapid response based on automated workflows across multiple applications.

Fig (9) IOC architecture prototype (Lacinák & Ristvej, 2017)



ICT smart city technologies are transforming the way smart city manage their everyday operations and services. The IOT and 5G technologies technology has caused thousands of connected systems being embedded in many a city's critical infrastructures, enabling city improving the stakeholders, residents' quality of life on their daily real-time activities.

In 2018, IBM found vulnerabilities in smart city sensors and researchers found vulnerabilities in a number of commercial smart systems, which enable hackers and attackers to remotely controlled systems (Lacinák & Ristvej, 2017). The security is one

of the key challenge issues of smart city and a challenge faced by researchers. New security technologies for smart city layers of sensors, IOT, transmission network wireless and wired infrastructure, data management, applications. Hardware, software new technologies are undergoing studies as well as proposed and restricted user guidelines has been issued by system analysts for privacy and security improvement.

6- How much smart to be smart?

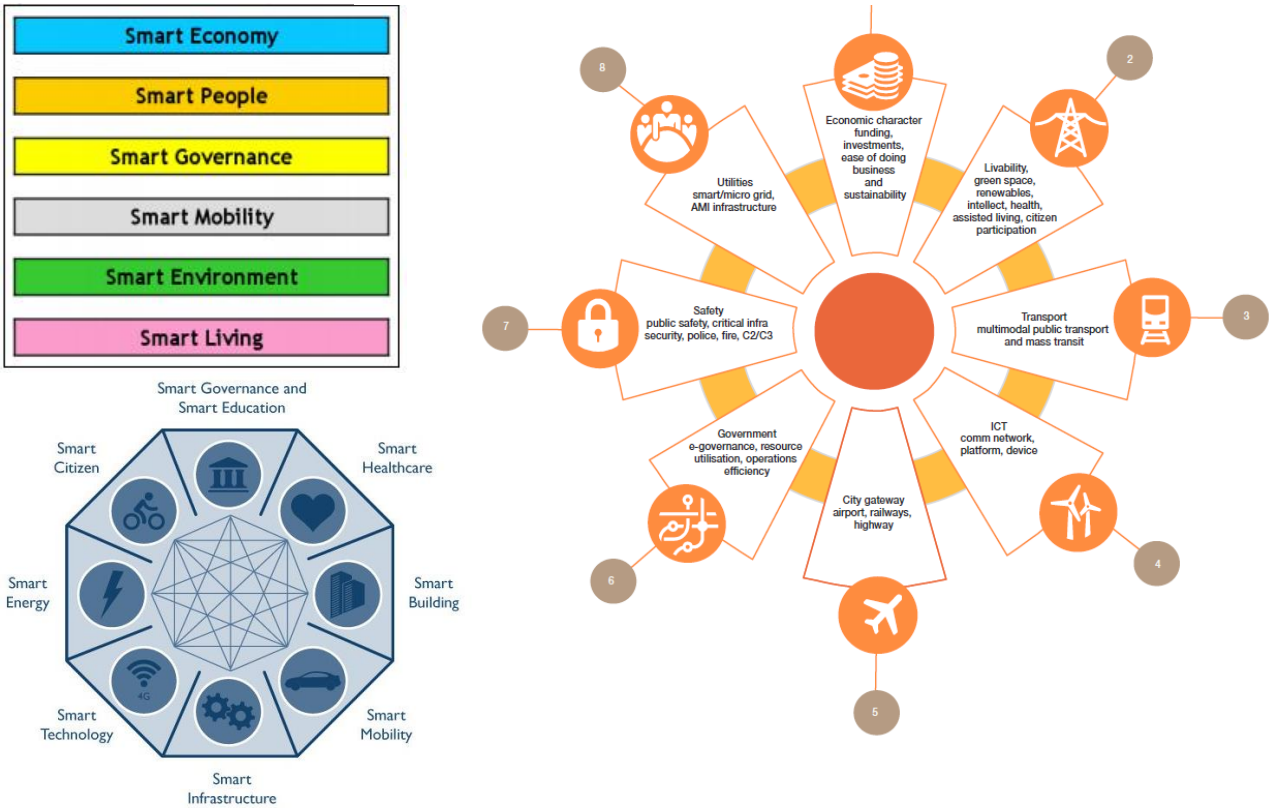
There are three main questions will arise in mind for the applications of smart city in the Egyptian cities and the research will attempt to answer them in next research sections.

1) Do we need to introduce smartness for all city sectors to be a smart city?
2) What are the main sectors must be smart to be a smart city?
3) How much smartness for a sector to be smart?

The objective of smartness is to promote cities to use ICT for improving quality of life to its citizens within clean and sustainable environment. In consequences, we might say that the conceptualization of smart city will vary from nation to nation, city to city and from district to other, depending on the city and district level of development, economic level, willingness to change and reform, resources and aspirations of the city and district residents.

Literature described the smart city as a city well performing mainly in six to eight initiatives, figure (10), and they allow an inclusion of additional initiatives. These concept and initiatives form the framework for the indicators and the following assessment a city's performance as smart city (Vu & Hartley, 2018).

Figure (10) Smart city main initiatives (Vu & Hartley, 2018)



To cope with such issues, the Egyptian vision of 2052 aims to build new future generations of sustainable environment cities with a total area of 580,000 acres to accommodate around 30 million citizens through using smart technology to enhance quality of life of its inhabitants by provision of minimum fundamental infrastructural facilities with better environmental conditions and better quality of life with supporting health and socio-cultural infrastructure ensuring mobility of people, goods and services. The new cities aims sustainability by managing its natural resources and using them effectively as well as using technologies to solve daily problems of to provide a better quality of life on the future Egyptian cities generations and living for everyone.

The Egyptian government represented by the New Urban Communities Authority (NUCA) has been working on relocating some of the capital's 20 million plus residents on new twenty of the fourth smart generation cities distributed across Egypt; they include the New Administrative Capital and South of New Cairo in Cairo; new 6th of October City, October Gardens, extension of Sheikh Zayed, New Sphinx, new Al-Warraq in Giza; El-Obour City, El-Qalyubia Governorate; New Alamein city in Marsa Matrouh; new Mansoura City in Dakahlia Governorate; extension of New Nubaria in Behaira Governorate; East Port Said "Salam" in Western Port Said; new Bir al-Abd inNorthern Sinai; new Al-Fashn in BeniSuef; new Mallawi in Minya Governorate; Western Assiut; Western Qena; New Luxor; and Toshka in Aswan (NUCA, 2018).

There have been several studies attempting to define the smart city initiatives for nations, but it is still a difficult challenge to tackle. A city nominated smart city is one that has realized a significant proportion of the smart initiatives. Thus, cities may be smart in different ways and to different degrees.

The research attempts to answer the question of which smartness initiatives make the Egyptian cities 'Smart City', as opposed to a traditional one?

The realization of Egyptian smart city depends mainly on the culture, issues and relations between components, actors, and strategies. Most of the analyzed frameworks agree on one or more initiatives but there is not a complete convergence among them and their relationships.

The research conducted face to face interview with 40 architecture and urban planner experts during a gathering workshop in TU Berlin campus El-Gouna, Hurghada from 21 to 24 December 2018. The goal of the interview was to define the main system components and features of the smart city and their priorities for the Egyptian Environment.

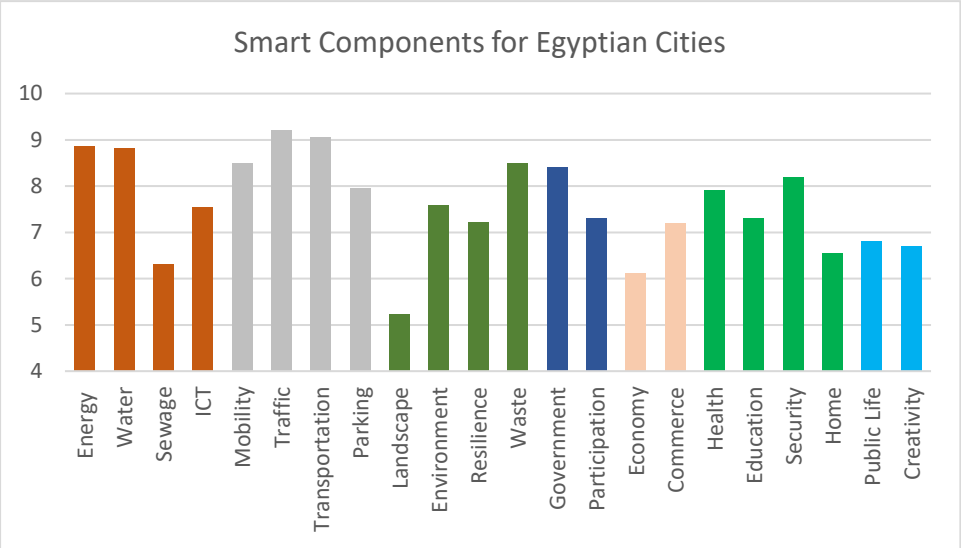
The interview is composed of two parts, the objective of the first part was to pinpoint the main smart initiatives and smart system components for a smart within the Egyptian environment. The interview listed twenty two major smart system components of smart cities recorded in all smart cities literature. Experts were asked in this part the following: "What is your expertise opinion of the following smart system components importance for the city sectors of Egyptian Smart Cities? (Give a score on a scale from 0 (not important) to 10 (essential) to realize the smartness of the Egyptian cities).

The second part of the interview focused on home smart system components, as an example of smart systems in the Egyptian cities, to examine their need for the whole residents within a city. The interview inquired the experts to express their opinion about the installation of nine given smart home systems for different economic level classes of districts (Low, Med and High income classes) to achieve sustainability and improve the districts resident quality of life. Part 2 of the interview ask the following for the experts: "Select the main smart home systems of the following which are required for each the three economic citizen level classes in the Egyptian Smart Cities". A logic variable has been formed from experts answer (0: false, 1: true) for the setting up of given smart home systems for the three economic classes of the smart Egyptian cities.

8. Analysis and Results

The expert responses for the two part of the interview were statistically analyzed using SPSS. Figure (11) shows the average score given by the 40 experts for the importance of each of the twenty two given smart system components within the Egyptian smart cities. The results shows that energy, water smart systems as well as the traffic and transportation systems are the main city systems pre-requests to be improved by introducing smart technologies to feel quality of life improvement of the Egyptian cities.

Fig (11) The importance of smart components for Egyptian cities



The twenty two given smart component systems were classified according to the main seven smart initiatives of smart cities as shown in figure (12) and the average scoring of each smart initiative were determined to identify the main characteristics of the Egyptian smart cities. The results in figure (13) shows that the smart mobility, infrastructure and smart governance are the main initiatives of the Egyptian smart cities.

Fig. (12) Classification of Smart City system components to the Smart city initiatives

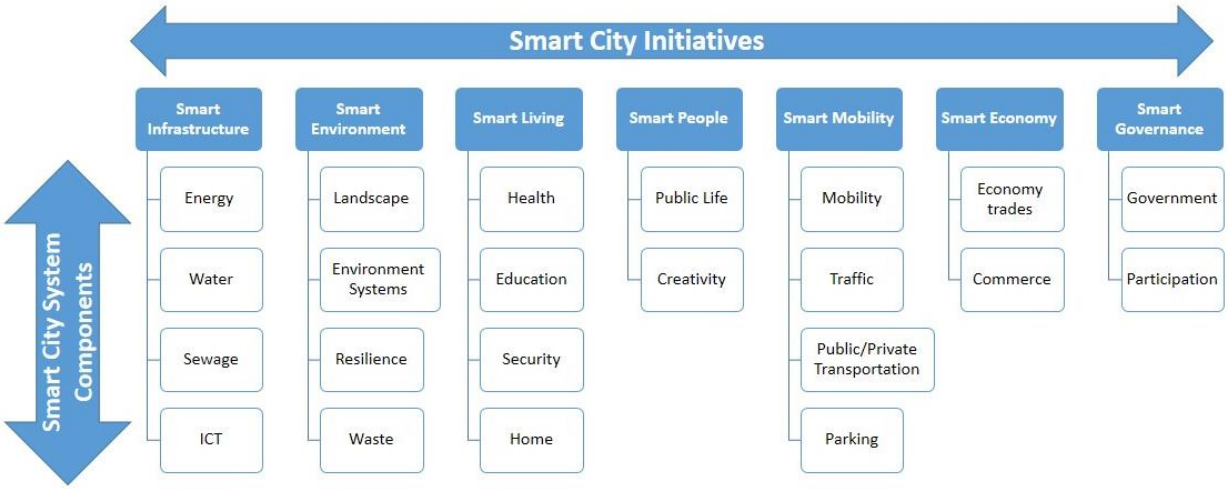
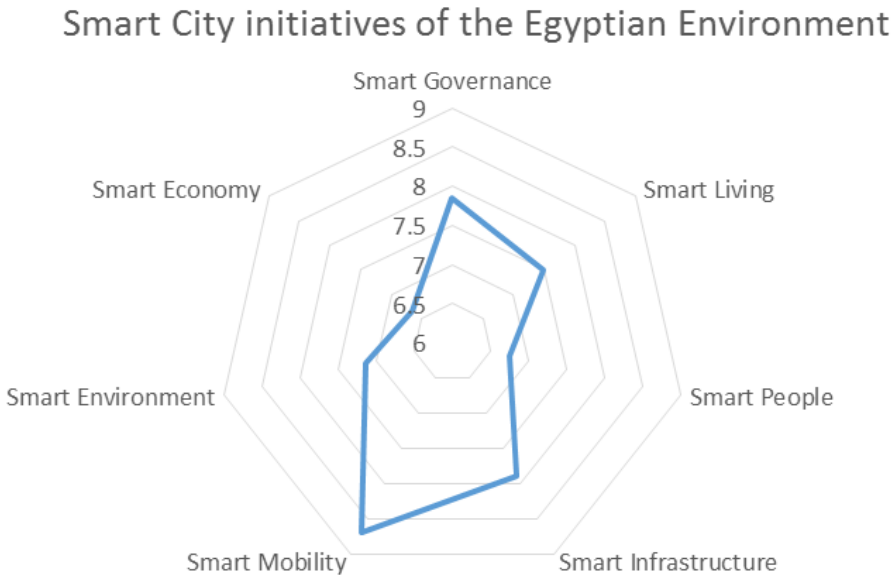
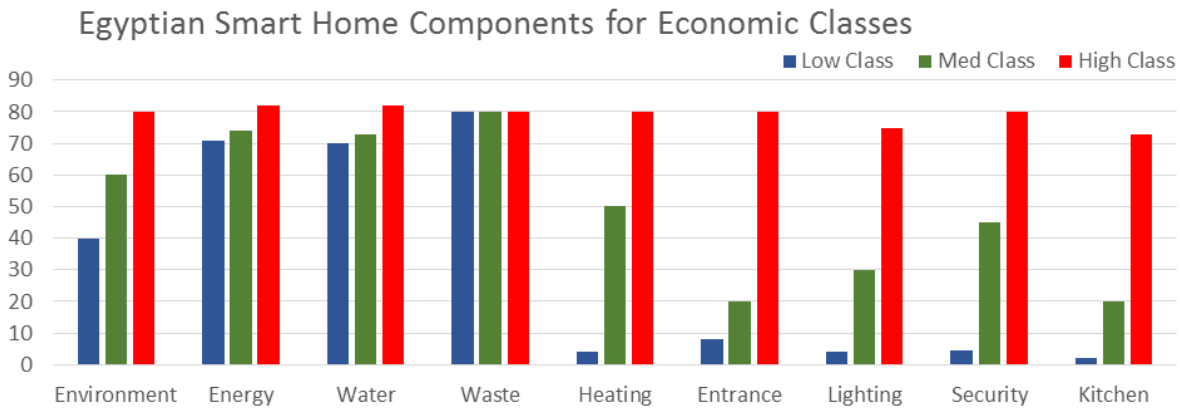


Fig. (13) Smart city initiatives in the Egyptian environment



The statistical analysis of second part of the interview, figure (14), shows that there are some smart system components are vital for the whole districts of the city and the for Egyptian smart cities: the smart infrastructure system components of energy, water and the smart waste systems are a need for improving the quality of life of Egyptian cities. The need of specific smart system components differ from a city to other and district to other depending on the city conditions and its main concerning issues and the residents' district economic level and their quality of life.

Fig. (14) Egyptian smart home system components for economic classes



The research claims that the Smart city concept might be the opportunity for Egyptian government to manage the impacts of rapid urbanization and their consequences of economic and environmental status and declination of quality of life. Studies and researches must be applied in the application of smart city in the Egyptian environment for better performance and the succession of such smart city concept

The smart city concept is based on using the rapid growing in the ICT field on the development of different urban and city systems performance for improving the quality of life and achieving the city sustainability.

The research argues that to achieve a successful smart city an architectural ICT infrastructure system must be satisfied within the city to let the ICT system to be flexible and perform successfully within the different city sectors and handle the large data volume of the daily city activities and realize the relations and requirements information between the different sectors in more intelligent manner to reach the accurate decision making.

Sustainability achievement and quality of life improvement cities goals are dynamic and different from a nation to other and within same city districts. The research concludes that there is no unique standards of the city smartness concept and a requirements need study must be considered before deciding the smart initiatives and the smart systems components to be installed.

The research attempted to identify the main initiatives of smart city in the Egyptian city. The research determines that nowadays mobility, infrastructure and governance are the main smart initiatives of smartness for the Egyptian cities. The research argue that water and energy smart components of infrastructure smart initiatives and the solid waste smart component systems of the environmental initiative are the main requirements for the Egyptian cities. Other smart component system requirements depending on the city concerns and the quality of life state of economic district level of the city.

There are different objective and vision of stakeholders for introducing smart city in the Egyptian environment; citizens, investment and business, government, communities and professionals. The research focused only on professionals vision and opinion and which might be the limitation of the research. Opportunities for further research emerge from such study limitation to examine and compare the different stakeholders' vision for the smart city initiatives and component systems for the Egyptian cities environment.

Four topics have been raised during the study of the smart city in the Egyptian environment. The research suggests further studies for the following topics:

- The consequences of the Egyptian inhabitants behavior and their acceptance for the smart city initiatives which will have a large consequences on the success and the performance of smart component systems in Egypt
- The feeling by citizens that smart technologies has put an end to the human privacy and their consequences on the traditional Egyptian communities' habits and social life.
- Who will be responsible of such smart city databases? What are the ethics and manner for using such sensitive data and what are used for?
- The neighborhood definition and the new city urban form to match smart city. The spatial urban patterns of the new smart land uses the intelligent operation

centers, data centers, E-commerce distributor stores and the routine performance of traditional services within the smartness environment.

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