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The Role and Important of Internet of Things in Building Sustainable City

Abstract- Every year many people migrate from country to city to live there. This will load a big pressure on the whole living in the city, Baghdad city also suffer from this problem in addition to other found problems like energy consumption , waste accumulate , Traffic congestion, noise, environmental pollution. To offer a good sustainable future living to population without any damage to environment and to solve many problems , one can use internet of things which is the connection network of the things especially with high spread of networks now which Internet of things based on it .the purpose of this research is to explain internet of things (IoT) and its role in solving many problems in the city , by using of the data collect by internet of things and to respond in real time to know problems and to enable planning and building city in a valuable sustainable way . As well as to explain the concept and models of smart city and its relationship to the sustainable city and Internets of things. In addition, to demonstrate in a simplified way the possibility of using the Internet of things to solve the problems in the Baghdad city and to raise the standard of life of its inhabitant is in a sustainable smart way. Taking this in the strategic planning of Baghdad city.

Keywords- Internet of Things, smart city, sustainability, sustainable City, Raspberry Pi 3.

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1. Introduction

Cities are one of the most important activities and human activities on Earth. The successive influences of human activities stem from the rapid population growth and urbanization as more than half of the world's population live in cities, in addition to the reliance on private motor vehicles Industrialization and large-scale poultry production all increase and cause significant environmental, social and economic challenges in global and local scales. Therefore, infrastructure and services are required to provide the necessities of the urban population and to increase the efficiency of the city administration [1-2]. The establishment of sustainable cities through sustainable urban development is the best solution to combat the environmental, social and economic challenges in the city in a responsible, effective and efficient manner to make cities more sustainable over time in terms of environmental and economic dimensions. It is suggested there is a continuous relation between urban planning and the development process in the city in creating an integrated mechanism to achieve the products of sustainability [1]. That rapid development of urban technology is an important factor to address the products of sustainability resulting from our cities and this led

to the development of smart cities. Increasing concern about the environment, civil and technological development is creating an urgent need and the possibility of rethinking how we reinstall and manage our cities. These things and their developments began with a rapprochement under the title of the Smart City. The emergence of information and communications technology such as Internet of things and big data is essential to the realization of the vision of the smart city [1,2,5,6]. The number of devices such as personal computers, laptops, tablets, smartphones, mobile devices and other handheld devices connected to the Internet is increasing at a rapid rate. Using a network of these devices with different sensors can give birth to many applications and services that can bring important personal, professional or economic benefits. This can lead to large business Internet of things since all the devices can be linked internally and connect with each other and on the Internet [3,7]. The Internet of things is ready to connect anyone at any time to anything anytime, anywhere. The basic idea is to allow independent and confidential communication to exchange of data between real-world devices and applications of the Internet of things. Its components consist of objects, sensors and communications infrastructure with the

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computing unit and processing, which can be found in the cloud computing and decision-making system and the evocation of actions [7]. For a city the Internet of things can use the structure of mobile networks with wireless sensors networks, which will be integrated with the civilized urban structure to be a digital layer. Information generated across platforms and applications is shared as a general operational picture of the city [4]. The interacting with various types of devices such as home appliances, surveillance cameras, control sensors, display players, vehicles and many devices, the Internet of things will accelerate the development of many applications that enable the use of huge amount of generated different data to provide new services to the city's residents, companies and the general administration of the city, so IoT promise to enhance people life quality in many ways [8-9]. Currently there are many cities have platforms or monitoring systems to see urban process indicators. There is an increasing need for municipalities to share internet of things that collect, analyze data for real-time response and response and the enable city administrate to take decision in many problems like air and noise pollution. [3]. The city of Baghdad, like any other city in the world suffers the increasing numbers of immigrants and the increasing population, which exacerbates the problems already exist in terms of energy consumption and the accumulation of waste and the increasing number of vehicles on the roads, causing heated congestion, pollution of air and noise pollution that add to the problem of the original traditional areas of the city population. The purpose of this research is to explain internet of things and its architecture, displaying its role in solving many problems of cities and leading to be smart sustainable cities.

2. Related Work

Zanella et al. [8] gave a survey of the techniques, protocols and the structure of the urban Internet of things, explain the concepts and services provided in the smart city, and show up the reasons for not realizing the smart city market because of many political, technical, financial obstacles. It gave an idea of the services of the model of urban internet of things such as waste management, noise control, traffic violation traps etc. Explain the components of the Internet of things using REST (Representational state transfer). finally the research presented a study on the Internet of things in the city of PADOVA in Italy. Arasteh et al. [3] provides a survey that briefly summarizes the concept and motivation of

using Internet of things for smart cities to facilitate the processes of knowledge of pollution in the air, noise and vehicles. It explained the using techniques like RFID (Radio-Frequency Identification), WSN (Wireless Sensor Network), how to address things, the middle layer and its role. It referred to the Internet of things applications of smart cities such as smart homes, vehicle traffic, and environmental pollution. Finally, the research pointed to the faced challenges such as security, privacy, and system resistance to attacks, data leakage, reliability, large-scale case handling, wide geographical area, large data problem and others. Rhee [11], the purpose of this research is to form a team called global city Teams challenge GCTC. The team designs and publishes replicable, scalable and sustainable solutions of things and smart city. The program is designed around several cities to address common challenges such as air pollution, traffic management, emergency response and creating teams called actions cluster. Each project is created with a specific timeline and the project is replicable in other cities to evaluate the solution and its benefits. Bonino et al. [12] presents a smart city platform developed within the almanac FP7 EU project. The application of a smart waste management scenario was for a medium-sized European city. It aims to integrate the Internet of things with the capillary network and metro access networks to provide intelligent services to citizens and provide smart city services. The platform structure consists of four layers and can be easily adopted by any city. Nitti et al. [13], in this research, a detailed application is carried out on the movement of cruise ship tourists in Cagliari, Italy. The Internet of things platform consists of four layers. The first is the real-world layer contains the real devices of the smart city, and then the virtualization layer, which is the borderline with the real world, the third service layer that is responsible for receiving the service requests and placing it in the atomic service available in the second layer. Fourth application layer provides services to customers. There is also a cross layer for quality requirements and communication security. There is a physical sensor at each entrance to measure the queue and collect data to send it to the third layer. Lanza et al. [2] shows how to integrate existing city services with an all-encompassing system. The research does a field trail with available real-time data about parking spaces on the city of Santander in Spain. This city is equipped with more than 12000 sensors distributed in fixed places such as buildings, buses, vehicles, using mobile devices for the

population, and putting sensors in several types, each with several functions to monitor the environment, control traffic, control of parking spaces. An internet of things is used to put its applications into action in this city.

3. Concepts

Sustainable city

Sustainable city: The sustainable city provide a balanced development in the environmental, economic and culture domains so that all citizens can meet their needs in the sustainable city and surrounding areas without affecting the natural world or damage the living conditions of the rest of the people now or in the future. [18]. The concept of sustainable cities should focus on policy and planning on urban infrastructure, mainly sewage, energy, waste management within the city [5]. The establishment of sustainable cities through sustainable development urban is a responsible, effective and efficient treatment to combat the challenges caused by the effects of human activities resulting from population growth, rapid urbanization, reliance on private motor vehicles, irregular production, and massive livestock production, which cause increased environmental, social and economic challenges at the local and global levels [1].

Smart city

Smart City it is the city that allows real world data to be collected and analyzed using software systems, servers, and client devices and take the information obtained in its activities and in decision-making. The city is a service organization and the population is the customer to provide services to them. The Smart City is a description of the application of systems and integration of urban infrastructure integration with services such as buildings, transport, electricity distribution, water distribution, public safety. The city's sustainability and intelligently will improve the ability to manage the city and the integration of physical and digital dimensions. [19].

Smart sustainable city

The meeting of the three considerations - sustainability, information technology, intelligent communication and sustainability-will demonstrate the city's sustainable smart expression. It is worth mentioning that cities can be made sustainable without the use of information technology and smart communications. Smart technology can also be used in cities without the participation of

sustainable development. To achieve sustainability it is important to know what uses smart technology to achieve sustainability and to know whether their use will bring about the desired results of sustainability [5].

4. What are the main air pollutants and its effects?

In this paragraph, explain what the most important substances that causes air pollution in cities and their effects, because of impact of these substances on the atmosphere of cities and their inhabitants.

Carbon monoxide: A colorless and odorless gas, a highly toxic gas generated by the incomplete combustion of fuel. Automobile exhausts and generators are a major source of this gas; the cars have the main role in producing it [14].

Carbon dioxide: Emitted by the combustion process, it is a natural gas in the atmosphere [14].

TSP: Micro particles that are solid or stuck in gas [14].

Air pollution affects humans, animals and plants have a clear environmental, health and economic impact on human health and low productivity. The increased concentration of CO, CO₂ gases leads to global warming, high temperature and its impact on the Earth's environment. Air pollution is characterized by rapid spread and extends its impact on areas other than the source area and cannot be controlled after the exit, so it must be controlled and processed it difficult to see. For TSP, increasing the proportion of soft particles in the air is accompanied by health risks such as heart disease and lung function [15].

5. The problem: the environmental situation in the city of Baghdad

In this paragraph, we review the status of the city of Baghdad from several aspects based on several research on various aspects related to the environmental situation and pollution in this city, and to indicate the status of the city and the city's need to find a sustainable solutions to address its environmental problems.

That migration to the city of Baghdad is one of the reasons for the increase in the population at high rates accompanied by the expansion of the city in all directions and on both sides of the Tigris River, also there are many problems in Baghdad city, especially in the old areas, like increasing the number of modern cars that generate traffic congestion, noise, visual ,environmental pollution and the negative effects of inappropriate services in the center such as electricity, a little water supply, bad sewage system, and the lack of a clear system of traffic

and the difficulty of entering vehicles. Not all this conforms to the correct standard environmental measurements that are required. There is a discrepancy between pedestrians and cars, inconsistencies in the type of vehicles carrying passengers and limited spaces of parking spaces for loading and unloading. All of this represents the phenomenon of declining life in a traditional environment [14]. In addition using generators lead to air pollution and noise pollution [14]. According to a research conducted in 2015 in many areas of Baghdad, The air pollutants in Baghdad (TSP, CO, and CO₂) have exceeded their standard limits varies from one location to another where these High concentrations observed at several measurement stations in Baghdad such as Kamaliyya, Kadhimiya, Bab al-Sharja, New Baghdad, Al-Mustansiriya intersection, Shaab, Sadr City [16]. This areas characterized by high density of the population and the increase in the number of cars in addition to the poor quality of fuel, as well as the old cars and industrial activities in them [16]. Sahar and et al [5, in another study, data from the stations of Andalusia and Waziriya of the Air Pollutants showed an increase in the percentage of pollution in CO gas, which is a primary pollutant emitted from car exhausts or factory chimneys. Car exhaust is one of the main sources of CO gas, collects in congested city center roads whereas its concentration is the highest and causes danger to the population; this is due to the large number of transportation. The transportation sectors are the main contributor to the production of polluting gases. This requires monitoring private and public transport [15].

6. What is internet of things?

Internet of things is a model that includes the Internet of the future. The Internet of things will connect things in the real world in a sensitive and intelligent way and extends intelligence in the system to handle the process of taking certain information from things and then making a decision [7]. The Internet of things consists of objects, sensors, a communications infrastructure, a computational unit and a processor that can be placed in the cloud of computing, a system of evocation, decision-making and action. Things have unique properties where everything has its own unique definition and is connected to the Internet. These physical objects are equipped with it. Sensors send information on the Internet to the processing unit and accounts. A combination of different sensors can be used to design smart services. The result of processing then transferred to the decision-making system and the reaction is

generated, which calculates the automatic action of the input [7]. In the content of the internet of things, the devices can be integrated according to the geographical location and evaluated by using the analysis system. The sensing system can be used to collect certain information to be used with many different projects that concern the control of bicycles, vehicles, public parking spaces and others. Smart city will be equipped with various electronic components such as street cameras, observation systems, sensors for transport systems can be used by different applications in the field of services that use the infrastructure of the internet of things for the purpose of facilitating the work on the subject of air pollution, noise pollution, the movement of vehicles and surveillance systems. [3]. so with lot certain data can be collected in real-time to processed, manage and analysis it to extract information which then becomes useful knowledge used. This will improve the decision-making process in city and population management to transform it into a smart city [3-4].

7. The internet of things Structure

The Internet of things infrastructure consists of five layers: First layer called perception layer or sensing layer. It represents the origin of the sensitivity in the Internet of things and deals mainly with knowledge objects and aggregated data. It includes physical objects and sensors. The thing is anything we want to be aware of and take information from. Sensors such as cameras, sensors, network sensors. The main task of this layer is to define the thing and collect the information from, which can be about the location, temperature, direction, movement, vibration, humidity, air changes etc. The information is passed to the next layer for the secure transfer of information to the information processing system. The second layer is called Network layer or Transmission Layer. It transfers the information safely from the first-layer sensors to the third layer. The transport medium, Wi-Fi or wireless and technology can be 3G, Wi-Fi, Bluetooth, etc. The third layer called Middleware layer or processing layer. This layer stores, analyzes and processes received information. It is responsible for the management of the service, receives information from the second layer, and stores it in the linked database. This layer implements the processing of information and the total calculations, takes an automatic decision based on the results, and provides general capabilities for all internet of things applications. The fourth layer called application layer. It

prepares global public administration for all applications based on information from third middle layer. Internet of things -based applications can be in health, smart home, smart city, intelligent transportation. The fifth layer called Business layer. This layer is responsible for managing all Internet of things system including applications and services. it builds work models, charts Based on the data and its analysis received from the fourth layer, and help in the calculation of future actions and strategies of work [7,17]. Figure 1 show the five layers.

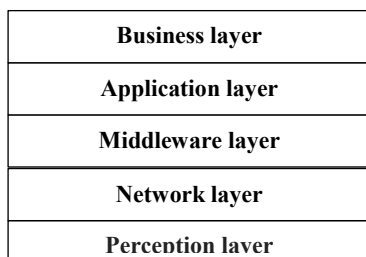


Figure 1: internet of things structure

8. Internet of things and sustainability

The Internet of things can be considered as innovative to avoid collapse, improve and promote sustainability in large cities [9]. Internet of things is one of the technologies that lead to smart cities and make the lives of the population smarter and more sustainability [9]. Many major companies such as Cisco, IBM and others have issued Internet of things that constitute an acceptable choice for many capitals and modern cities. The internet of things is the key enabling factor for smart cities today and in the future. The Internet of things strengthens the goal of Smart Cities by improving the quality of life of its inhabitants in different ways [9].

9. Effect and role of Internet of things in the city

The use of Internet of things affects various considerations of the city's smart residents such as health, security, transportation, education and others. It can also play an important role at the national level in accordance with policy decisions in energy conservation, pollution reduction, remote monitoring and other as well as the infrastructure required. Based on this, the Internet of things will help to equip a better, more efficient, more economical and secure system based on economic considerations, energy conservation policy and confidence levels [3]. The Internet of things leads to cultural change and new services will be created with new

features to be the basis of the Smart City and make the lives of the population smarter and more sustainability. Internet of things applications found in many areas such as home automation, industrial engines, traffic management, energy, transport, waste management, surveillance systems like monitoring bicycles, motorcycles, vehicles and public parking spaces, and environmental management such as facilitate water pollution, noise pollution. All these areas and their needs can be covered by Internet of things which can be considered as innovative to avoid collapse, improve and promote sustainability in large cities. [9] [8] [3]. So the city of Baghdad can benefit from the Internet of things to solve many of its environmental problems in the form of small individual solutions to solve a specific problem such as solving the problem of traffic congestion by creating a mobile application signifies crowded streets and sends messages to subscribers, this will help to reduce the Traffic congestion or putting Internet of things system in the basic plan of planning the city of Baghdad, this will be a comprehensive solution.

10. Smart city models

There are many smart cities around the world such as Masdar City in the United Arab Emirates, Songdo City in South Korea, many cities in China such as Meixi, Padova in Italy, Malta smart city in Malta, Plan IT in Portugal, The city of Lavasa in India as well as many smart cities in the United States and Europe. Masdar City is a smart, sustainable city close to Abu Dhabi. The focus is to be a city with zero carbon content, built with sustainable materials. It is an example of reducing energy use, managing waste and using clean energy vehicles. The city is fully equipped with solar energy and renewable resources. There is a focus on clean air, education, sport, tourism. It is a sustainable socio-economic city [20].

Barcelona is the capital of Catalonia. Working with Cisco, Internet of things has been made to provide better services to the population and visitors. It is called internet of everything. 500 km of fiber network built in underground, where smart bus stops are connected to it, real-time bus schedules and tourism information are also available. People can to connect to the internet freely when they wait for the bus. The city smart parking spots are associated with Barcelona's Wi-Fi network. There are wide networks of sensors that provide real-time information about population flow, noise sensitivity and other environmental pollutants, traffic and climate conditions, this enables local authorities to

streamline the city's operations, including Achieving better environmental management, reducing costs, improving the economy and achieving environmental sustainability. In this city, street lights are connected to the underground Wi-Fi network and are equipped with several features like CCTV, air quality control sensors, energy portfolio, waste containers equipped with thermally sensitive waste levels and data sent to city council team to plan the best way to assemble Waste in real time to improve productivity and reduce the cost of waste management service. As a result of the use of the internet of things, a total of 47,000 new works related to the development of the Smart City in Barcelona have been created. The provision of financial resources is achieved through the efficient management of lighting and the import of parking spaces [9].

Padova, Italy The city has a network of wireless sensors equipped with more than 300 points used by PADOVA University. The project was carried out in cooperation between the sponsor the city council and the PADOVA university. The primary goal of padova smart city is to embrace open data solutions and intelligent communication technology solutions in public administration. The application aim is to collecting environmental data and monitoring Public Street lighting by means of wireless points equipped with different types of sensors placed on streetlights and connected to the Internet through a gateway unit. The system collects environmental data such as carbon monoxide level, air temperature, humidity, noise, and street lighting by measuring the intensity of light at each position [8].

11. Security

One of the most important problems that Internet of Things systems suffer from is the data security for users and maintains their confidentiality, as the weak and unorganized networks that are associated with the use of internet of things are vulnerable to abuse and attack, Note that networks are a basic principle in the Internet of things. Therefore, the Internet of things platform must be a strong security building, especially for smart city environment and must be characterized by security mechanisms from end to end and Encrypt data. Encrypt data automatically, especially in communications to provide secure connection between things of real world and virtual. Access is organized and flexible to the authorized, where different types of users have multiple levels of data access depending on ownership, security level, appearance and others.

The virtual objects in the Internet of things architecture have three types of allow, the public where access to the source is available to each person without using any key, the private source is accessed only by the key owner, the friend can access the source by the friend key to the virtual thing. At the same time, the cloud-computing environment used within the Internet architecture provides the security needs within it. Internet of things behavior when are attacked must be with rapid response, identification, and repair in real time. [13,21]

12. The Practical

A small experiment similar to how the Internet works was done. The DHT 11 sensor is connected as a single sensor node with the Raspberry Pi 3 PC operated by Raspian Operating System, which is one of the Linux versions. The small pc connected to the LCD screen. The Python application was implemented in the Raspberry Pi 3 PC, which reads from the DHT11 sensor bound to the pin 22 for both heat and humidity at a location in Baghdad. Raspberry Pi 3 PC connects to internet via Wi-Fi (the EarthLink network), these sensor readings are sent via the Internet by Lambda function to store in a database contains a table store sensor values. Both Lambda function and database located in the cloud computing. Figure 3. Shows the Experiment.

Results: The user can review the table of temperature and humidity readings from any browser, whether it was opened from mobile or tablet or laptop and know the temperature and humidity of that location in the Baghdad city. Figure 4 shows the results.

The hardware and software used in the mini-model for practical experimentation can be matched with the components and layers of the Internet of things architecture, where the DHT11 sensor is similar to the first layer-sensing layer. The Wi-Fi is similar to the second layer Network layer or Transmission Layer. Moreover, Lambda function Layer as the Middleware layer or processing layer. In addition, the database is similar to the fourth layer application layer. In addition, the website, index .php is similar to the fifth Business layer.



Figure 2. Raspberry pi 3 PC



Figure 3: The Experiment

Date	Sensor	Temperature	Humidity
2017/05/22 11:30:00	Arduino	31	75
2017/05/22 11:45:00	Arduino	31	75
2017/05/22 12:00:00	Arduino	31	75
2017/05/22 12:15:00	Arduino	31	75
2017/05/22 12:30:00	Arduino	31	75
2017/05/22 12:45:00	Arduino	31	75
2017/05/22 13:00:00	Arduino	31	75
2017/05/22 13:15:00	Arduino	31	75
2017/05/22 13:30:00	Arduino	31	75
2017/05/22 13:45:00	Arduino	31	75
2017/05/22 14:00:00	Arduino	31	75
2017/05/22 14:15:00	Arduino	31	75
2017/05/22 14:30:00	Arduino	31	75
2017/05/22 14:45:00	Arduino	31	75
2017/05/22 15:00:00	Arduino	31	75
2017/05/22 15:15:00	Arduino	31	75
2017/05/22 15:30:00	Arduino	31	75
2017/05/22 15:45:00	Arduino	31	75
2017/05/22 16:00:00	Arduino	31	75
2017/05/22 16:15:00	Arduino	31	75
2017/05/22 16:30:00	Arduino	31	75
2017/05/22 16:45:00	Arduino	31	75
2017/05/22 17:00:00	Arduino	31	75
2017/05/22 17:15:00	Arduino	31	75
2017/05/22 17:30:00	Arduino	31	75
2017/05/22 17:45:00	Arduino	31	75
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2017/05/22 19:30:00	Arduino	31	75
2017/05/22 19:45:00	Arduino	31	75
2017/05/22 20:00:00	Arduino	31	75
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2017/05/22 21:15:00	Arduino	31	75
2017/05/22 21:30:00	Arduino	31	75
2017/05/22 21:45:00	Arduino	31	75
2017/05/22 22:00:00	Arduino	31	75
2017/05/22 22:15:00	Arduino	31	75
2017/05/22 22:30:00	Arduino	31	75
2017/05/22 22:45:00	Arduino	31	75
2017/05/22 23:00:00	Arduino	31	75
2017/05/22 23:15:00	Arduino	31	75
2017/05/22 23:30:00	Arduino	31	75
2017/05/22 23:45:00	Arduino	31	75
2017/05/22 24:00:00	Arduino	31	75

Figure 4: The Table

13. Conclusions

This research is to understand internet of things and its solutions and applications in the cities. Specific concepts about internet of things were reached such as Smart City, Sustainable City and the possibility of using Internet's of things to achieve sustainability in the city, whether smart or not. Also shows the structure of the Internet of things and its layers.

We can benefit from development in the information and communication system and electronic devices such as sensors, players to solve the existing problems in cities by using internet of things. Where it become as a tool to create knowledge based on the huge amount of data obtained from the city.

The use of the internet of things in the city is based on the existence of many electronic devices and subsystems locating on real things like buildings, Lighting columns, vehicles and many other objects. These Internet of things systems and its applications are useful for solving many problems that cities need, such as solve traffic jams and traffics accidents in real time. It is prefer integration of these systems to reduce the cost and avoid the contradictions in the decision-making. This will lead to the sustainability of the city.

The use of Internet of things will bring technological changes to the daily life of the city's

residents, thus raising the quality of life, making life more comfortable and simple.

There are many applications for internet of things in all areas like medical, industrial, transportation, education, control, security, tourism and others. The Control, measurement systems are important and necessary especially in smart cities.

A small, one node sample experiment simulates Internet of things was used to measure temperature and humidity and send data to the cloud computing. The results of this mini-experiment showed the availability of the technological hardware and software components required to create Internet of things platform like sensors, communication networks, software, cloud computing services, laptops, smart mobile devices and more in Baghdad city and show the possibility to set up Internet of things applications.

In this way, the Internet of things can be used to solve problems in the city of Baghdad like traffic jams, air pollution, noise pollution, waste collection problems, security problems, etc. This will make life more comfortable and raise the standard of living of its residents and sustainability of the city. The use of internet of things can be tailored according on the status and problems in the city. The decision of using Internet of Things should be part of the strategic planning of the city of Baghdad after the completion of governance, although it can be done gradually until reaching the smart and sustainable city concept.

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