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A Survey of Smart City Development and the Role of Internet of Things

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ABSTRACT

The Internet of Things (IoT) is an innovation that has improved the old way of system existence into an evolutionary high-tech system. Examples of such systems that are transformed by this technology are: smart urban areas, smart households, pollution control, energy-saving, smart transport systems, smart manufacturing owing to IoT. Various critical research training and surveys are done to improve the technological system using IoT. There are some issues considered at different facets of IoT applications, such as supporting technologies, socially and ecologically. This article discussed the applications of the Internet of Things (IoT) in smart city development, the diverse problems and vital issues of IoT design, and key applications in some cities in Nigeria. Some existing literature and their role in diverse areas of IoT were discussed. The article offers deeper understanding on the need for smart cities and IoT's role in smart city development and smart mobility.

1. INTRODUCTION

The collective usage of smart devices in recent times gives an idea of the importance of our day-to-day activities. With a single click on the button, one could interconnect with a person who's far away, and get the fastest route to a place. This states why the scenario is considered smart. Hence, a smart City, consist of smart technology with physical or logical applications of all systems which accept and deliver data intended to analyze and learn. This makes it adapt and adjust its behavior to fit its environment.

1.1 Internet of things (IoT)

The concept of IoT just as a smart city has evolved. This term was incorporated into a popular term called the internet. IoT deals with the creation, collection, analysis of data between devices (mechanical or digital) over a network without human interaction (human to human or human to device) (Ukadike *et al.*, (2023); Ajenaghughrure et al., (2015); Akazue and Ajenaghughrure (2016)).

A major concept and evolutionary views IoT as a machine-to-machine (M2M) communication. This requires machine systems to connect and manage data between themselves. IoT introduces a sensor-based network that provides data connection to smart devices (Meola, (2016); Akazue et al., (2024); Akazue (2016)).

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IoT is directly connected to smart development; there is a connection between the internet of things (IoT), smart devices and schemes. Their work stated that a smart city must be successfully implemented to enable it work with an IoT structure, and to manage a smart city. It was further stated that data is a key feature for modernization or improvement, and is used by a huge range of institutions, organizations, and research firms. In IoT, data is collected, measured, analyzed, and reported by both human and machine for processing.

The idea of a smart city has been in use since the '90s (Rode, et al., 2019) work focused on the fact that a 'smart city' means 'smart citizens' where citizens have all the information needed to make appropriate choices about their lifestyle, work and travel choices. Generally, by population, a smart city is any locality in a rural or urban area which attempts to recognizes and resolves existing and upcoming problems using scientific assistance for the populace's purpose of population for its populaces.

2. SOME AREAS OF INTERNET APPLICATIONS IN SMART CITIES

Cohen (2015) divided smart cities into three major categories. The first is technology-driven Smart cities. These are smart cities that focus on a technology-cantered environment that appeals to urban technology innovators. They are built based on technology solutions, through organizations which are aimed at providing a competitive advantage in the technology-growing industries.

Smart governance: the capacity to employ intelligent and adaptive acts and the activities of looking after and making decisions about something (Scholl and Alawadhi, 2019).

The concept of a smart city has numerous factors and technological terms involved with past and present implementations. The evolution of various smart cities is built by very clear bodies which are involved in all connecting building blocks to the smart city wall, (Ismail, 2018; Taiwo 2016).

United Nation (UN, 2019) stated that the world's population urbanization by 2030 is expected to increase astronomically; this population's increase shows that there is an immediate need for management of resources. Major cities and states have seen a massive increase in population in the past years and possibly will even get more populated in future to come. An example is Lagos, Nigeria, which has seen tremendous population growth, with an estimated twenty-one million (21 million) in recent times, compared to 1970, which was 1.4 million, and it is estimated to increase at a growth rate of 3.4% every 5 years (UN, 2015).

London's population grew from 6.8 million to 7.15 million in 1999 and has continued to increase to 8.77 million people in 2017, and it is estimated to reach 10 million or more by 2041. London's gross value in the United Kingdom has seen an increase in numbers, from the year 2000 to 2017, almost doubling in figures with over 421 billion British pounds in 2017, (Statista, 2019). London is one of the well-known smart cities. In recent times, there are cities in London that use electric vehicles enabled by IoT and sensors, with more focusing on its transportation system, making its citizens utilize public transportation and decreasing the consumption of fossil fuels (Luciano, 2017). In this scenario, smart transportation, smart people, and smart economy solutions are being implemented, with more than eleven numerous smart city projects, like smart underground parking services and its large free Wi-Fi network

systems, which are projected to be Europe's largest (Luciano, 2017).

In 2009, the biggest known smart city campaigns were launched by the international business machines Corporation (IBM). A year later, an ongoing global economic crisis that led to the great recession. The goal was the campaign to provide solutions and new methods to protect and manage resources, therefore saving money and improving citizens' quality of living, as well as counter upcoming recessions with the help of fast-growing interconnected information systems. Currently, numerous smart city plans are underway in various countries such as India. India targets the development of 100 cities across the country and aims at a sustainable and citizen-friendly environment (IBM, 2015).

Hudson and Kortuem (2017) identified in their research an idea template for setting up a structure for smart city project development. Smart city projects take a lot of time for planning, their structures are complex and interchangeable.

Mediterranean Region (2017) stated how Ascimer adopted an approach that uses urban challenges and subdivided into different groups based on the dimension of the smart city and the concept which they agreed to use. Information about the various challenges was collected from several sources, such as international organizations, governmental organizations, environmental surveys (field visits), citizen surveys, and researchers, to develop a smart city.

Meijer & Bolivar (2015) identified some challenges faced in the Lagos by governance system. They identified a gap between the government and the governed; they concluded that there is a gap between the leadership and the citizens concerning financial, political, and social perspectives that must be brought closer. They recommended an urban institutional capacities Framework for urban administration in regions having shortcomings in formal foundations (and a general shortcoming in informal governance). These challenges could be addressed through smart city development.

Mediterranean Region (2017) further stated how Ascimer identified some challenges associated with smart cities, such as inequality, education, and cultural differences. There is a need to reduce the distinctions and improve the quality and access to information, education, innovation, and financial resources. There is also the threat of losing one's cultural Identity, landscape and architectural plan, which are commonly used to identify cities. Traditional activities should be persevered and promoted. Lack of digital skills and low educational levels. Continuous self-learning and skill acquisition is needed in enabling a smart environment. These are lacking in developing countries. All levels of education need to be increased in other ways to tap into the community's potential development.

Akazue et al. (2024) produce an Application using RFM model on Customer Segmentation in Digital Marketing.

Akazue and Ajenaghughrure (2016) developed a system using Internet of Vehicle Speed Detection and Reporting System Based on RFID. Akazue and Onyekweli (2015) it is an efficient way of measuring using of power.

Akazue and Ajenaghughrure (2015) developed a model, which uses big data for effective decision making.

Akazue et al. (2023) development a model using Semantic Web Framework for the

Blind, the model was specifically for the blind.
Ajenaghughrure et al. (2015) developed a Hybrid Intelligent application that uses Fuzzy Logic system to detect the influence of alcohol in driving system.
Ajenaghughrure et al. (2017) developed a model using Fuzzy based multi-fever symptom classifier diagnosis.
Ako et al. (2024) used XGBoost and Random Forest to Predict Customer Churn via a Comparative Effects of Data Resampling.
Akazue (2017) used Users' Perception to develop an Intelligent Automatic Fire Detection System for Developing Countries.
Ojugo et al. (2023) use an ensemble model to develop a User-Trust Hybrid Memetic Modular for Card Fraud Detection via Neural Network.
Akazue et al. (2024) development an Enhanced Agricultural system Systems for Developing Countries using Greenhouse technology.
Akazue M. I., (2016) used an Automated Fuzzy Logic Based Temperature Control Model to model for a Sustainable Server Room Temperature Stability; the model was very efficient in predicting the room temperature.
Ajenaghughrure et al. (2016) developed a model for vehicle theft prediction-prevention and recovery using Ant colony optimization algorithm based system model (aco-vtp2rsm).

A vast section of Lagos inhabitants work in private establishments or set up self-owned corporations and the living earnings are reported to be unsatisfactory (Wagesindicator, 2016). The author was able to identify the need to improve and develop a healthier lifestyle, and provide improved social sustainability generally to populists. Some gaps were identified in the area of information access, due to the lack of available media, and also in the way data is distributed between various levels of government agencies. There is need to improve the social services and create better working and living environments, by improving social services. Cultural changes and demographics in developing nations require an improvement in social sustainability. All these can be achieved through smart city development.

Ascimer (2016) identified in their research that developing a simple smart city is a complicated challenges. This is because it requires several stages and sub-stages. These involve several parties in the development process. Identifying a city's challenges gives a narrow plan on what is to be focused on, but development guidelines cover layout processes. They developed a smart project framework that shows the development stages and the importance of stakeholders' involvement in this process, they also establish some key guides, as stated above.

Granier and Kudo, (2016) viewed a smart city as a way to give rise to smart people and this makes them the main focus of the project, which indicates that they are critically involved in every development process of the smart city and their solution. The citizen should be involved at the early stages of development; their early participation in active projects reduces the risks of missing out on their benefits.

Ahvenniemi et al. (2016) identified that some internal stakeholders are more active within the city and would not function without the city's functionality. This consists of citizens, public servants, local economic, social, and research department agencies. Citizens have been represented to be the core of a smart city.

Lagos is a city in Nigeria with a port and is one of the most populated states in Nigeria. It is also one of the nation's major industrial and commercial centres. It accounts for 65 percent of industrial and commercial activities (World Bank, 2018). This makes it a large growing city, its population is estimated to increase by 5% every 5 years (World Population, 2018). There is need therefore to develop a smart city for it populist to meet its urbanization challenges, as its population increases.

There are numerous challenges which Lagos state is faced with, and this makes living a tussle and sustainability is a major difficulty. With a smart solution in place, these challenges will be solved. Lagos is one of the world's fastest-growing merger cities. It also lacks infrastructures like other big cities infrastructure, it is estimated that half of Lagos' population resides in the slum regions due to cheaper living expenditure expenditure amongst other factors, Daming (2019).

2.1. Smart Mobility Solution

The introduction of electric transportation systems, going electric has constantly been a speaking point for corporations. Nations are in search of smart mobility solutions; this has been accepted by leading nations such as the United Kingdom (London) and the United States (New York), among a list of several others in their public transportation. Electric vehicles have been in existence for a while now with top vehicle producers on board since their popularity in the 1890s and Toyota was the first to mass-produce hybrid vehicles in 2000, (Energy Gov, 2019).

A Lagos air quality monitoring study from 2007-2009, shows that vehicles contributed to approximately 43% of the entire level of air pollution in Lagos state and a rise in vehicle registration accounts shows vehicle ownership by 5% yearly in vehicles in Lagos motor vehicle statistics 2010. Electrically powered vehicles should be officially introduced to the public via public transportation. This is important as it will help in handling the problem of carbon dioxide emissions. The benefits of electric or hybrid vehicles for smart mobility are as follows: cleaner energy, thus emitting less pollution, reduced fuel dependences, (Taiwo, 2016). Advised city transportation companies to adopt a standard system for a different region. Where possible, the transport companies' operations and network routes should be overseen by the Ministry of transportation in the case of Lagos metropolitan area transportation authority (LAMATA), in Nigeria. This sets the transport networks for the following: Routes Connections: Citizen Accessibility, Research data, Good Service delivery, Easy Approachability of stops and stations. BRT, The proposed transport network for Lagos (Nigeria), is a projected transportation network for its major transport mode in Lagos by the Lagos metropolitan area transportation authority, (LAMATA). Utilizing data and IoT in transportation network systems is a necessary project for development and frequent evaluation. Transportation planning and research on all modes of transportation should be carried out, starting from its backbone mode in the case of road vehicles.

Taiwo (2016) stated that IoT could help in real-time bus tracking, and traffic control with which could make bus trips faster and therefore more reliable. This will reduce the rate of private vehicles and personal mass transportation and ease traffic congestion and pollution.

2.2 Discussion

A smart city is a technologically industrialized city which uses the City of things (IoT), sensors and the Internet for

vehicles. These are used to reorganizing the city with guidelines established to create things that will improve and sustain its citizens' well-being. A smart city will change to a reformed city, with the help of technology. Smart city developments will certainly take a lengthy period to establish. A smart city system helps in solving different challenges faced by urbanization, such as transportation systems, air pollution, as experienced in some cities like Lagos in Nigeria, London in the UK.

By leveraging IoT technology in developing smart mobility systems and electric cars. Stakeholders should consist of experts in various fields; research institutions, financial institutions, government bodies, and citizens and organizations. Each decision and survey should be carried out by this body of stakeholders.

Conclusion

Resolving the mobility division is a gateway to more infrastructural development in urban city development.

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