Internet of Things-Supported Smart City Platform

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Abstract. The modern Internet of Things (IoT) technologies are facilitating projects from smart cities around the world. The IoT offers the ability to track, handle, and operate machines remotely and to create new knowledge and actionable information from vast real-time data sources. Robust and practical approaches to smart cities already faced obstacles. The latest information and communication technology (ICT) implementations for smart cities are focused on specialized structures that are not fully compliant, compact, extensible, or economical throughout cities. This paper highlights how diverse firms are working jointly to diminish the barriers in the way of smart city resolutions, and potential gains along with IoT related problems for cities are addressed. There will be a debate on the needs of intelligent cities, the role of IoT technology to make cities more stylish and better, and the best wireless technology for smart cities. The examples of five cities are shown as cities measured according to several research criteria, including smart grid systems, smart lighting, and the application of digital technologies for traffic, wireless internet, mobile penetration, and app landscape. Secured and trusted smart cities and core security objectives are also presented. Inside a community of IoT technology, large-scale implementation aims to make city operations effective while recovering the quality of life for urban residents.

1. Introduction
To create, implement, and encourage sustainable growth activities and to tackle urbanization issues, the smart city is an ICT platform. This ICT architecture is part of an interconnected network of linked artefacts’ and machines that transmits data utilizing cloud and wireless technologies. Cloud-based IoT technology analyses and manages data to assist communities, enterprises, and people in making more decisions that better their lives [1]. Smartphones or mobile devices, connected cars and homes are being used by citizens to interact in various ways with smart city ecosystems. The integration of sensors and data with the existing facilities and resources of a city will minimize costs and improve sustainability; the connectivity of all devices is shown in Figure 1 [2-3]. There are several benefits of smart cities. Some benefits include public facilities that will maximize electricity availability, streamline waste disposal, reduce pollution, and with IoT assistance, even enhance air quality. For instance, connected traffic lights are fitted with light rate details and time changes for sensors and vehicles, mitigating road congestion, to respond to real-time. Connected vehicles may connect directly to the closest accessible place through parking meters, electric car charging points, and passengers. Intelligent waste management can send data automatically to waste processing companies and arrange
pick-ups on demand, rather than a pre-planned timeframe [4]. Citizen's mobile is a wireless driver license and ID token, speeding up and enabling travel to and connections to community and municipal government facilities. As a result, infrastructure, connectivity, public services, and amenities are maximized together [5-6].

Figure 1. IoT in Smart Cities.

2. The Need for Smart Cities
Fifty-four percent of the global population currently resides in towns, projected to hit 66 percent by 2050. Urbanization is a non-ending phenomenon. In tandem with increasing population growth, urbanization over the next three decades will add 2.5 billion more inhabitants to cities. Economic and socially sustainable growth is essential to keep up with the rapid growth that taxes the wealth of our cities. One hundred ninety-three nations ratified the UN framework of Sustainable Development Goals in September 2015. However, collective actions and activities can take time to implement a projected framework. People and municipal councils are agiler in implementing fast projects, and intelligent community infrastructure is necessary for the progress and achievement of these objectives. The level of smart cities is shown in Figure 2 [7-8].

3. Role of IoT Technology
Safe wireless networking and IoT technologies are turning conventional city-life features into sophisticated digital lighting systems, including street-light displays. It involves solar integration and the link to a central control network centred on the cloud that connects to other ecosystem properties. Embedded high-efficiency LEDs notify traffic drivers, include extreme weather alerts, and heads up when fires are environmentally-friendly. There will be street-lights adjacent to free parking space, charging stations for electric cars, and warning drivers. The open spots of these facilities can be found via mobile Apps. In some cases, charging could also be possible from the lamppost itself. There are four essential elements, alongside people, residences, trade, and traditional urban infrastructure needed to flourish smart cities, as shown in Figure 3 [9-10].
4. Wireless Technology for Smart Cities

A secure and robust wireless networking is the first component of any smart city device. Although there is no one-size solution, emerging LPWAN innovations are well designed for cost efficiency and ubiquity for the most stylish city applications. They include LTE Cat M, NB-IoT, LoRa, Bluetooth, and many others, which all contribute to the connected town production system. The introduction of 5G technologies is a landmark occurrence that encourages intelligent community infrastructure and speeds up new implementations. But with just a few additional elements, state companies and people have traditionally kept their data tight to the chest and exchanged it with others as often as possible [10-11]. The perceived value of information sharing has far outweighed privacy concerns and fears of security violations. However, a crucial element in sustainable smart cities is to exchange knowledge and to integrate it with qualitative data, which is processed in real-time by all actors of this dynamic ecosystem. In-depth decisions are thus taken in real-time. In-house real-time contextual knowledge
exchanged amongst sector-specific OT structures in higher demands, and efficient collaboration [11]. Figure 4 shows smart cities wireless technologies components. Governance covers municipal and strategic policy records, job growth incentives, regional development, and industry incentives. Wireless infrastructure is made up of citizens for instruction, medical treatment, public health, schooling, and development in mobile, physical and interactive communities with innovative solutions. Wireless communication includes travel, electricity, natural resources, and farms, as well as illumination, ventilation, properties, and maintenance infrastructure [12-13].

Figure 4. Wireless Technology in Smart City.

5. Examples of Five Smart Cities
In recent years, since the Market Research Company, Juniper Research (Basingstoke, UK) has been hosting Singapore as the most knowledgeable city on Earth with other facts relevant to the cities of the planet. Several research criteria have been measured in cities, including:

- The implementation of smart grid systems, intelligent lighting, and the use of digital technology to boost traffic, Wi-Fi, mobile penetration, and application landscape.
- Open data channels have been regarded concerning mobile applications, mobility, and public knowledge systems with power.
- The essential elements of smart cities, such as the different weightings, are added to transport and electricity.
- The public transit choices were seen as points of access for towns with substantial rates of possession of private cars.
- Efforts have also been made to boost travel, to incorporate congestion charges, innovative lighting, the use of road sensors, and amusing parking.
- So far as electricity use is concerned, the measures that communities adopt, such as the smart network, their smart meter installation, and what sort of renewable energy approach the city authority has adopted.
- The economies of major cities with smart city initiatives were also considered [14].
The details of the top five smart cities accessed based on the points as mentioned earlier are briefly discussed below.

5.1 Singapore
Smart city smart mobility strategies, infrastructure, and wireless networking are given the top scores. The city-state announced in 2014 that its program Virtual Singapore was developed. The dynamic 3-D model helps community officials to perform simulation experiments, for example, to determine whether crowds would escape from an emergency site. Security and security remain vital goals, and the government has to work hard to ensure the data is encrypted as appropriate. In addition to substantial expenditure in road signs, elevated traffic signals, and sophisticated smart car charging, Singapore has now aggressively implemented congestion charges, thereby guaranteeing the provision of high-speed television and sensor-built parking facilities. The role of the city-state of transit isn't shocking, because the government has a long tradition of using information technologies to boost travel. It initiated an effort in the 1970s to fix what an issue of persistent congestion was at the time. Since then, Singapore's programs have been very involved in raising the average speed travelled on main roads by vehicles. The area has a high penetration of the mobile and performs well when it comes to coverage of broadband. They carry out a 10-Gbps broadband fiber infrastructure, which will allow people to watch a two-hour HD video in 90 seconds. The service is one of the worlds inexpensive by national currency dependent on the broadband market. Singapore already has an open data portal about sensor data gathered on the island. Any cities execute smart city programs and don't make their results freely accessible [15].

5.2 Barcelona
Barcelona, north-eastern Spanish futuristic capital, Catalonia, has used sensors to map traffic and control it heavily. City planners recently announced their aim of re-structuring the flow, which is decreased by 21%. The region is doing more to raising traffic with intelligent grid technology. Auto parking and computerized road lights, as well as air quality and noise reduction systems, have been introduced. Also, a free Wi-Fi network in public areas is being created. The annual Juniper Study round of Barcelona fell a rung from the leading position in its last year. Nonetheless, the study group lauded the environmentally friendly initiatives of the region, which it said are substantially higher than those in either New York City or London. The power of Barcelona rests in its clean electricity smart grid demonstration programs, smart meters, and its ambitious carbon pollution reduction strategy. It's rolling out smart LED lighting on top of that. Barcelona has always been a trailblazer in fighting drought. Some years ago, the town ran out of the sea. As a result, it built an intelligent irrigation sensor network for the city. The field sensors monitor temperature alongside the predicted meteorological activity, enabling sprinklers to be changed in the area to aid water conservation. The town has also made its Sentilo sensor and actuator network available for the public. The database can be located at Github for open-source software. This openness is used for investigating and gaining from the results of Barcelona's insightful urban projects around the world [14-15].

5.3 London
London has long been at the forefront of the list of sophisticated communities around the globe. Early advances have started with the usage of technology to combat pollution and encourage parking. London, one of the world's development hubs, is also on the internet. The local authorities have recently announced a plan to incorporate new technology for congestion management. London is now dedicated via its London Data Store to make the data accessible to the public through its intelligent city initiative. London, for example, has an open data system that can take you to your place so you can decide where you want to go, and the system can inform you of the roads you will follow. In 2014 London started carrying out a Westminster area smart parking project. While being outstanding in many ways, London's ranking was lowered because it relied on fossil fuels and its comparatively inadequate efforts to minimize electricity usage.
Nonetheless, it is forward-thinking about how it handles traffic through technologies. For the next decade, London has planned a £4-billion increase in roads and £200-million in the bus network. The region has heavily invested smart technologies. The lights not only react in favour of busses to promote the development of public transport, but they also imposed a congestion fee in 2003. To keep the congestion driver trained, communicating is required. In this way, pollution is a shared collective effort. The growth of the city will not, therefore, add to the number of automobiles on the route. The city was never designed for vehicles like other European cities [14-15].

5.4 San Francisco (SF)
The desert area is one of North America's first smart-technology city: SF Silicon Valley is the unofficial centre of the new technological transition. San Francisco is now hipper for entrepreneurs rather than neighbourhoods, so tents are helping residents find parking spaces. The city is still forward-looking with its sustainability and comprehensive urban development initiatives. The organization also has one of the most significant living densities approved for LEED in the USA. Nevertheless, metropolitan travel has been diverted by the new technical revolution. The community will address this dilemma and transform SF into a national intelligent transport network. While aging, some places still perform well in the SF public transit network. The region ratings are high in terms of connections to busses. There's a strong payment network in San Francisco too. People may pay online, and contactless payment is also possible. Today, during the latest technologies’ revolution, the city faces a growing issue of emissions. Nevertheless, the city has been a leader in smart car parking. Since 2011, the SF Park initiative leverages sensors to monitor car parking spaces. The premise is not just that you can determine the degree of parking usage, but helps the cities handle new parking measures. City authorities in San Francisco use the data for an elaborate parking scheme, which changes parking rates depending on whether spaces are filled or empty [14-16].

5.5 Oslo
Oslo, the world's most prosperous city, is regularly listed as a candidate in rankings of the world's cleverest towns. By leveraging information technologies to reduce carbon consumption and greenhouse gas pollution, the city has made strides. In 2020, the region expects to reduce pollution by 50 percent by reshaping the energy grid; by 2030, it intends to be carbon neutral at 95 percent. Oslo has mounted sensors for parking power, like most other smart cities. The city has created a sensor network for disabled people to improve services. The city has built a smart street lighting system that reduced nearly two-thirds of the energy usage. The city is also attracting criticism for its ambitious efforts to curb a vehicle's carbon emissions.

Nevertheless, at the closing stages of the decade, they are going to ban private cars. The region does have a high level of personal vehicles at present. The overall solution to energy management in the region is indeed somewhat positive, as in Barcelona. Sustainable energies and emissions policies provide a high share. Oslo also started introducing intelligent LED lights and set up a broad-based traffic control network. They have automated identification technology, which connects with the congestion charging scheme. Smart parking apps are available to enable mobile payment [16].

6. Secured, Trusted Smart Cities and Security Objectives

Added monitoring and emergency management mechanisms to assist people as needed can be aided by mobile vehicles, smart road networks, and public service tracking systems, but some questions still exist.

- How about shielding the smart cities themselves from vulnerabilities?
- Why will we face up to ransomware, cyber-attacks, and data theft?
- How do we believe participants in cities where multiple participants share knowledge are the ones they pretend to be?
- What do we think of the specifics they reported?
The answers lie in environmental data reservoirs, secure identification, and security strategies for authentication. Intelligent systems can only work if we can trust them [17]. All business stakeholders—states, companies, software suppliers, system vendors, electric utilities, and content delivery networks have to make their mark in providing a solution that accomplishes four key protection goals, as shown in Figure 5.

**Figure 5. Security Objectives of Smart City**

6.1 Availability
Without secure, reliable, and actionable data exposure, the smart city can't succeed. It is becoming increasingly necessary for collecting, distilling, and sharing information and preventing adverse effects on the development of protective solutions.

6.2 Integrity
Smart communities rely on precise and accurate tests. It will be carried out to measure the accuracy and security of data abuse.

6.3 Confidentiality
Personal user awareness itself is part of the information gathered, stored, and evaluated. We will take steps to ensure that sensitive data is not unlicensed.

6.4 Accountability
Device owners should be liable for their actions. Interactions will be registered and linked to a specific responding systems entity. These logs should be challenging to construct and should be kept secure for credibility. The functional protection and ID management tools will be integrated into the system to ensure that data is only shared with approved parties. The large-scale implementation inside a group of IoT technology aims to make city operations effective while enhancing the quality of life for urban residents. For mission smart cities, data collected and distributed via IoT networks must be guarded to prevent cyber-attacks that could disrupt city functions, steal personal data, and cause catastrophic harm [18].

7. Concluding Remarks
This paper illustrates how several companies work together to reduce barriers to smart city initiatives and address future benefits along with IoT-related city issues. It addresses the need for smart cities, the
role IoT technology plays in making cities more fashionable and safer, and the best wireless technology for smart cities. It also presented examples of smart cities, stable and trusted smart cities, and core safety goals.

For intelligent towns, high-performance LEDs notify traffic drivers, provide critical weather updates, and head up when fires are environmentally safe. The streets light next to free spaces, charging docks and warning drivers can be identified. Intelligent community design covers municipal records and strategic policy, economies, and incentives for jobs. The smart community mobile infrastructure comprises citizens for security, health services, protection, education, and connectivity in physical, interactive, and virtual communities. Smart city strategies will develop interoperability and enforcement test centres and frameworks. Extendable, open-access technology and specifications can whenever feasible, be adopted/designed to require unbiased approaches from low cost/sustainable/seller.

The smart street luminescence requirements are necessary for healthy cities and, thus, for intelligent street lighting, for LED lumens, implementation instructions, backup procedures, etc. For supervision such as camera decisions, deployment guidelines, etc. and almost every other application field, similar standards are required. For several city applications, low-cost IoT smart devices are needed that are tailored to city standards and open data models. In most cities, cameras are a significant investment, and we should be able to do more with them. Intelligent video analytics are essential for the effective use and support of cameras for many new applications. Distributed/edge analytics, especially for video, must be explored near the camera. For mission smart cities, data collected and distributed via IoT networks must be guarded to prevent cyber-attacks that could disrupt city functions, steal personal data, and cause catastrophic harm. Additional monitoring and emergency management mechanisms to assist people as needed can be aided by mobile vehicles, smart road networks, and public service tracking systems. A variety of measures is used to determine the best cities in the fields of smart lighting and to improve traffic, broadband internet, smartphone access, and device environment. Open data channels have been regarded concerning mobile applications, mobility, and public knowledge systems with power. Added control and emergency management services to assist people, if required, can be assisted by mobile vehicles, smart road networks, and public service tracking systems with security constraints.

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