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A comprehensive review on IoT based smart cities

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Abstract

A smart city uses information and communication technology to improve the utility, share knowledge with the public, and provide a strong sense of community support and local government assistance. Shrewd urban communities are those that make use of brilliant ideas and information as the required resources to address the maintainability issues that urban communities face. Many metropolitan areas are currently becoming more intelligent, utilizing information and innovation to advance transportation, energy consumption, wellness, and air quality, as well as to spur economic growth. A great city's main objective is to streamline municipal operations, promote economic development, and address resident happiness through clever developments and data analysis. We intended to spend a great amount of time reading up on several shrewd urban groups in this post. As a result, some of the key boundaries that can be built include clever management, clever energy, clever building, clever flexibility, clever structure, clever invention, clever medical care, and clever residence. Urban areas collect and analyze information using IoT devices such as connected sensors, lighting, and meters. The foundation, public usage, and administrations, to name just a few, are all progressively developed in urban areas using this knowledge. Smart urban communities focus on improving the lives of their residents in such fundamental areas as strategy effectiveness, reducing waste and everyday problems, improving friendly and financial quality, and enhancing the social consideration of their residents.

Keywords: IoT, Smart Cities, Cloud, Arduino Nano, IR Sensor, Ultrasonic Sensor, LDR, Relay, Alarm

1. Introduction

The Internet of Things (IoT) is a fresh perspective on computerized connectivity that envisions a not-too-distant future in which everyday things will be fitted with microcontrollers and smartphones. Intelligent display stacks will equip them to communicate with one another and the clients, evolving into an essential component of the Internet. Smart, self-designing objects that are connected to one another through a global organizational framework are anticipated to be produced under the IoT model. IoT is typically thought about as real, widely distributed, low capacity, and managing products with the aim of advancing the unwavering quality,

performance, and security of the brilliant city and its frameworks. Due to the ongoing population growth, development is necessary [1]. The Internet of Things (IoT) is a novel approach to computerized networking that predicts the fitting of everyday objects with microcontrollers and smartphones in the not-too-distant future. Intelligent display stacks will enable them to interact with clients and one another, developing into a crucial element of the Internet. Under the IoT concept, it is envisaged that intelligent, self-designing items would be created and connected to one another through a global organizational framework. IoT is often viewed as actual, widely dispersed, low capacity, and controlling items with the objective of enhancing the bright city's and its systems' unwavering quality, performance, and security. Development is required because of the population expansion that is happening [2]. The Internet of Things (IoT) is a novel approach to computerized networking that predicts the fitting of everyday objects with microcontrollers and smartphones in the not-too-distant future. Intelligent display stacks will enable them to interact with clients and one another, developing into a crucial element of the Internet. Under the IoT concept, it is envisaged that intelligent, self-designing items would be created and connected to one another through a global organizational framework. IoT is often viewed as actual, widely dispersed, low capacity, and controlling items with the objective of enhancing the bright city's and its systems' unwavering quality, performance, and security. Development is required because of the population expansion that is happening [3,4]. These are some challenges of a smart city are following:

Lack of funds: As urban communities try to work on their foundation with brilliant innovations, paying for such undertakings presents a significant test while presenting savvy advancements for an enormous scope.

Governance: The implementation of these large-scale projects involves a long series of legislative and policy agreements.

Lack of infrastructure and labor: Metropolitan foundation assumes an essential part in savvy city projects. Contingent upon the current foundation in energy, water, and transportation frameworks, among others, a task might be figured out requiring pretty much speculation time.

Digital Security: In intelligent cities, the interrelationship between public and private is possible thanks to the flow of data.

Infrastructure and services are needed to meet the needs of city dwellers due to the rapid increase in population density in metropolitan areas. Due to the ability of all devices to connect to the Internet and communicate with one another, there has been considerable growth in the use of digital devices, such as sensors, actuators, and smartphones.

Advantages of Smart City:

- Automatic Switching of Street lights.
- Maintenance Cost Reduction.
- Reduction of light pollution.
- Keep the city clean.
- Improve traffic and reduce parking times.
- Reduction of manpower.

The objectives of this paper are as follows:

1. To study smart cities of overall countries.
2. This review is focused on the last decades of smart cities.
3. Smart parking system using IoT.
4. A smart street lighting system using IoT.

5. Garbage monitoring system using IoT.

The organization of the paper is as follows. Section 2 provides existing methodology. The results are discussed in section 3. Section 5 provides a conclusion.

2. IoT-based smart city

The following Figure provides and illustration of an IoT-based smart city.

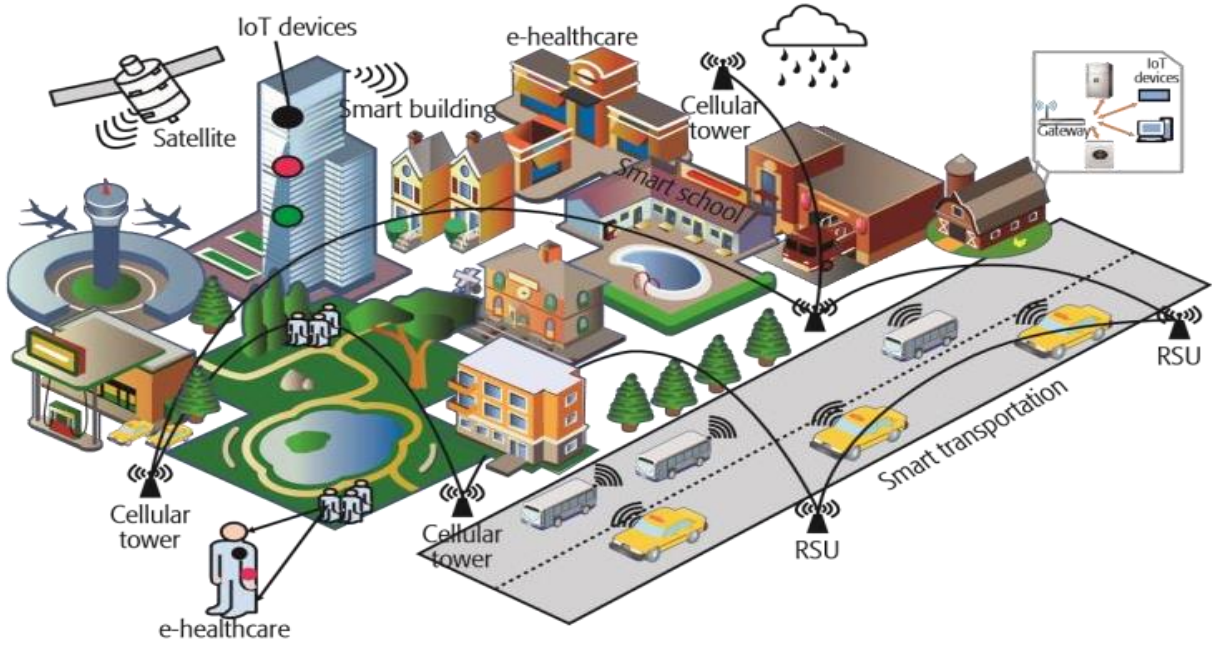

Figure 1. An illustration of an IoT-based smart city

The IR sensors, LDR, PIC16F877A microcontroller, relay, UART, and Wi-Fi module make up the ingenious street lamp's construction. LDRs are light-dependent devices, and their blockage grows in the dark and shrinks when exposed to light. A light-dependent resistor has a high resistance when maintained dull. The vehicle that is passing the streetlight is recognized by an IR sensor. The streetlight bulb can be turned on and off during the transfer. The Universal Asynchronous Receiver/Transmitter (UART) software on a microcontroller manages the PC's connection to the associated streetlight framework [7].

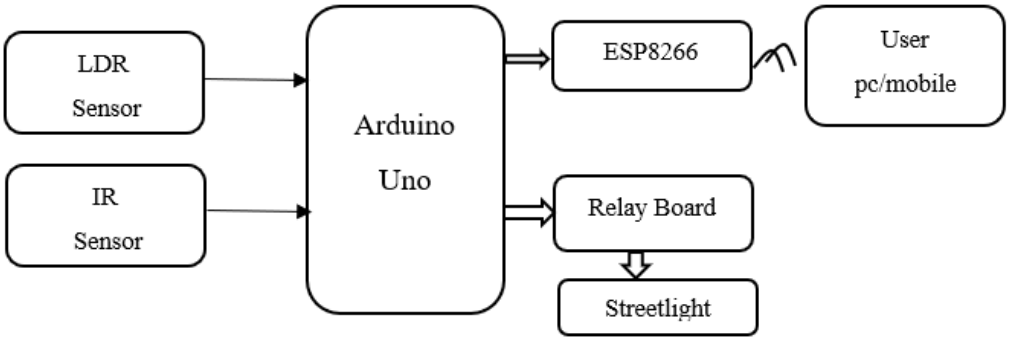

Figure 2. Block diagram of smart street lighting system [5]

The clever street lamp's structure is made up of IR sensors, LDR, PIC16F877A microcontroller, relay, UART, and Wi-Fi module. LDRs are light-dependent devices whose blockage expands in darkness and decreases when light shines on them. When a light-dependent resistor is kept dull, its resistance is quite high. An IR

sensor identifies the car that is driving past the streetlight. During the transfer, the streetlight bulb can be turned on and off. A microcontroller with software known as a UART (Universal Asynchronous Receiver/Transmitter) controls a PC's connection point to its connected streetlight framework [5].

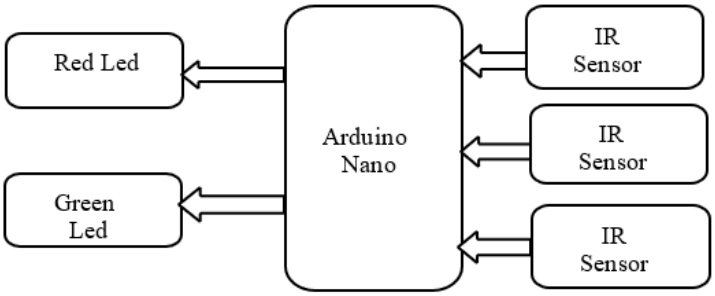

Figure 3. Block diagram of smart parking system [8]

It is divided into three areas. The parking area is the first, and it includes an IR sensor and Arduino devices. With the aid of these devices, the client establishes a connection with the halting location. Without the aid of an RFID card, the user is unable to enter the parking space. The cloud-based web administrations, which serve as a go-between for the client and the stopping region, are covered in the following section. Depending on whether a parking space is available, the cloud is updated. The user can view the admin to see if the cloud services are available, and the admin manages the cloud services. The user side is the third section [8].

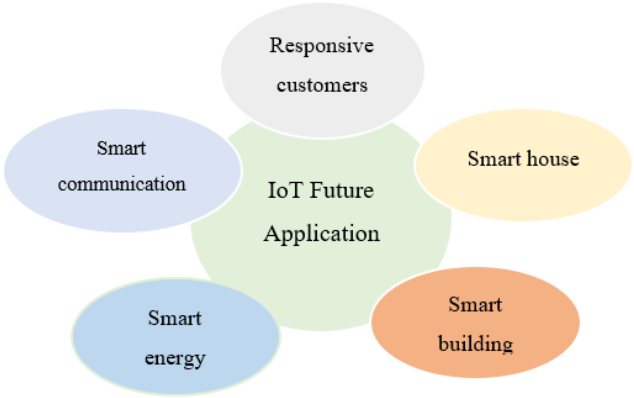

Figure 4. IoT potential application [9]

A few administrations that work with the climate may emerge as a result of the IoT's successful implementation. It can then open up a variety of contextualization and geo-mindfulness options. Heterogeneous hardware permits the mechanization of comparative and customary workouts using the IoT stage in homes and buildings. The execution of administrations via web interfaces is undoubtedly possible when transforming items into the information of apparatuses that are completely connected via the Internet. Huge numbers of sophisticated home applications use sensor networks [9]. The government (at the municipal, state, and federal levels) should deploy IoT services in all crucial issue areas to enhance government information systems and administration [6].

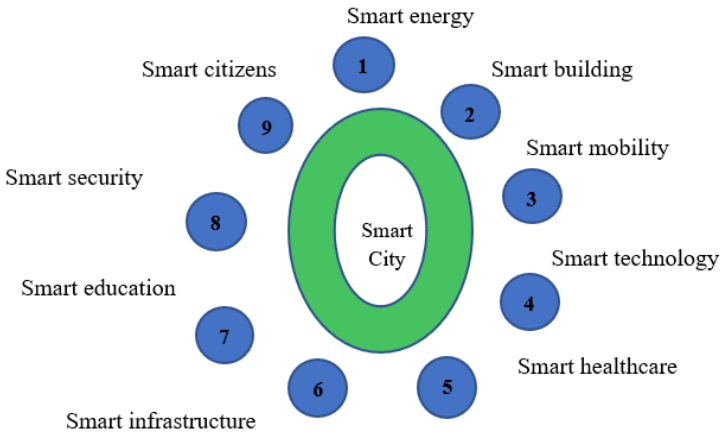

Figure 5. IoT based interconnections

The latest developments in computerized innovations have made shrewd urban regions even more shrewd than previously. A smart city has sensors for transportation systems, road cameras for perception systems, and other electronic components that are used in numerous applications. Additionally, this may increase the use of personal cell phones. This way, different concepts like article highlights, givers, inspirations, and security standards should be investigated while accounting for the diverse climate [10].

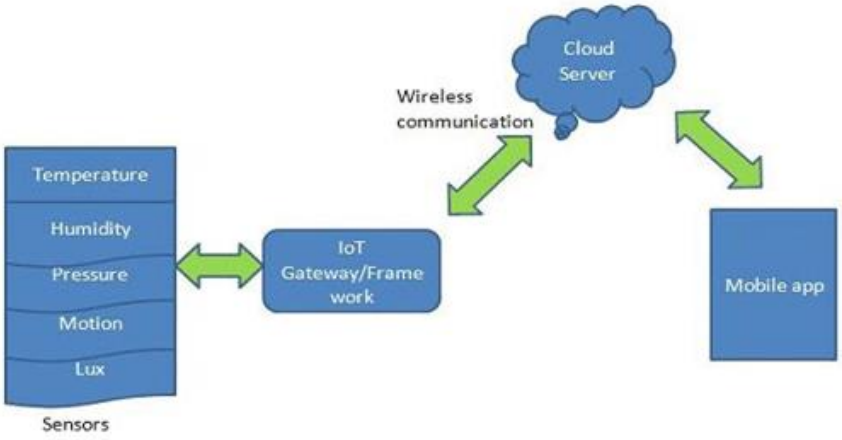

Figure 6. IoT Architecture [11]

We need to create a schematic architecture that allows us to quickly and easily depict the complete process in order to demonstrate the plausibility and suitability of this framework, as illustrated in fig. We can infer from the architecture that the system as a whole is a combination of essentially just two different components. The first is a traffic control system, while the second is a street lighting operation [11].

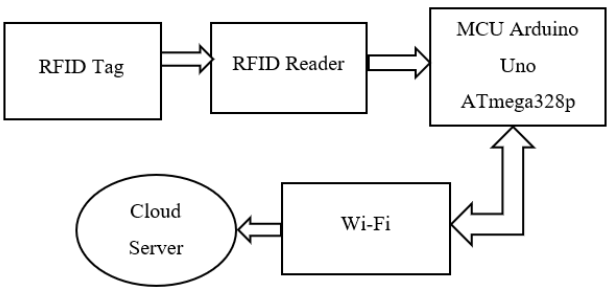

Figure 7. Block diagram of parking system [7]

The parking devices and sensors are then installed in their parking zones by a team of parking installation workers who then travel to the parking place. Things and personality-specific gadgets were where the Internet of Things (IoT) concept first emerged.

The devices might be monitored, controlled, or tested using distant Internet-connected PCs. [12].

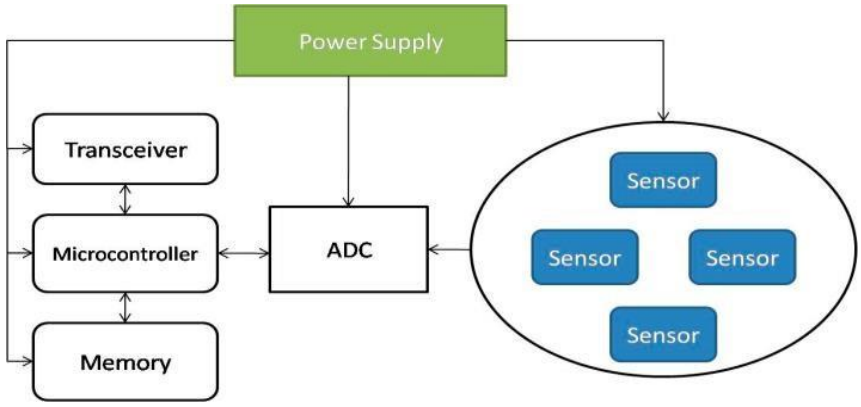

Figure 8. The architecture of wireless sensor node [9]

WSNs make diverse genuine information available and can be used for many things, including government and natural administrations, healthcare, and many other things. Additionally, WSNs and RFIDs can be combined to achieve a variety of goals, such as gathering data about the whereabouts of people and objects, developments, temperatures, and other things. A WSN is made up of distant sensor hubs that have a radio point of contact, an analogue to digital converter (ADC), a number of sensors, memory, and a power source. [9].

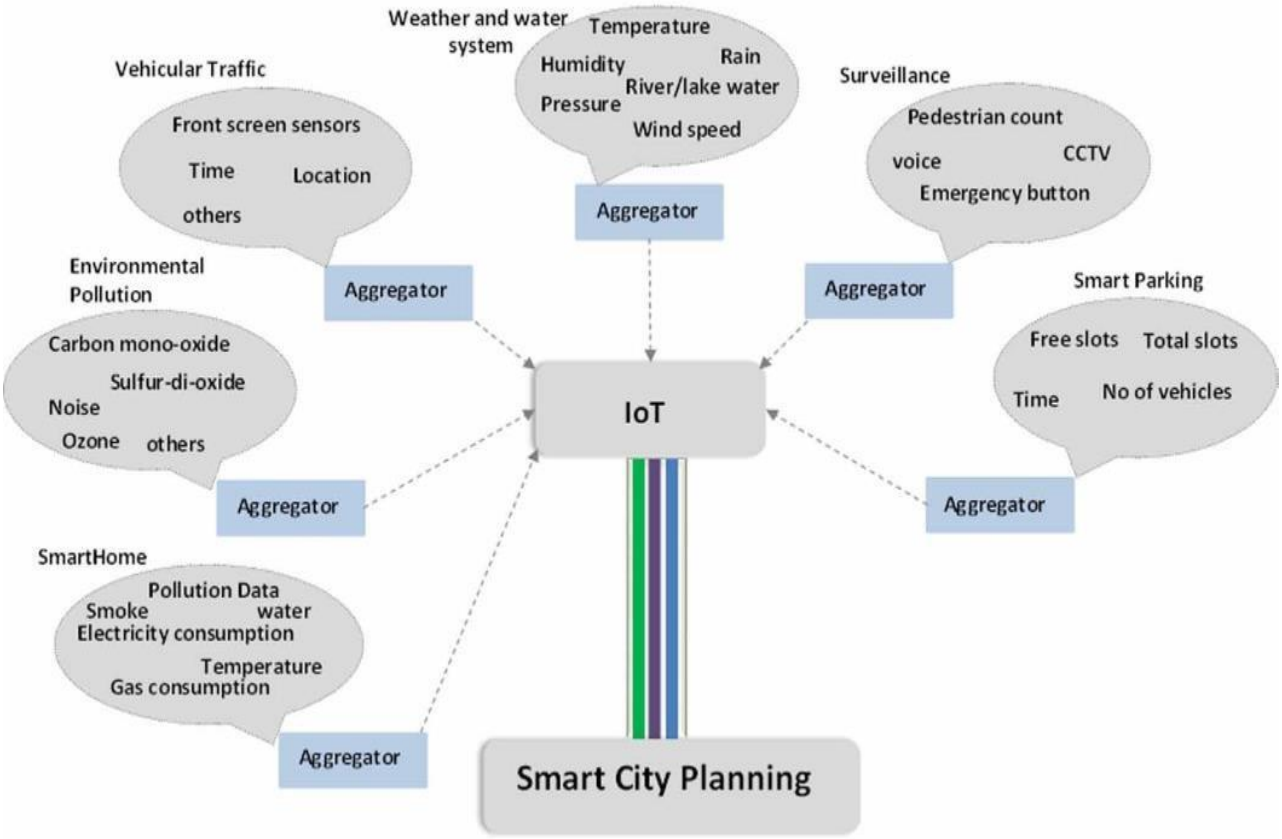

Figure 9. The architecture of smart city planning [13]

The IoT-based smart technologies are integrated for city data creation for developing the next-generation Super City, as depicted in Figure. Data from those smart systems are kept in big storage facilities so that they may be later examined for Super City planning. Government officials can assess last year's electricity consumption and

estimate the demand for electricity in the upcoming year using data supplied by smart homes. Municipalities can therefore implement the required action to meet future needs and develop a long-term plan for creating new dams to increase energy production [13].

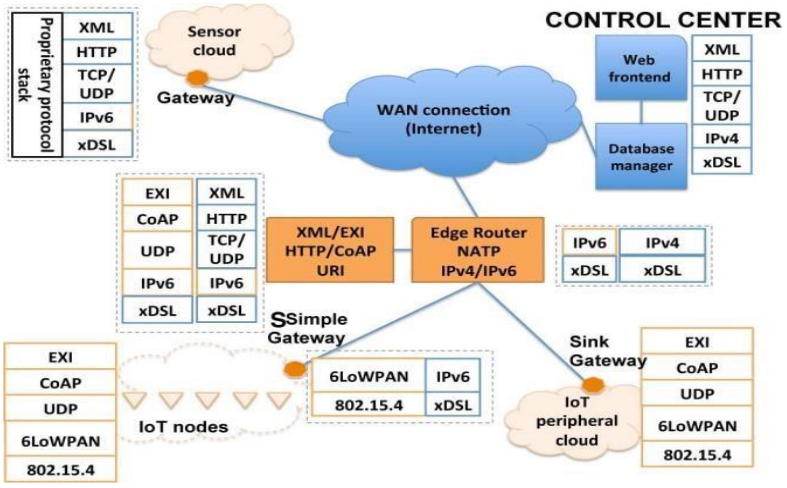

Figure 10. Conceptual representation of an urban IoT network based on the web service approach [14]

We briefly go over the connection layer innovations that can be used to connect the various components of the IoT before we start outlining the web administration approach for the design of IoT administrations, which requires the organization of reasonable convention layers in the various components of the organization, as displayed in the convention stacks portrayed in Fig. Last but not least, we show the varied configuration of devices that consent to an urban IoT [14].

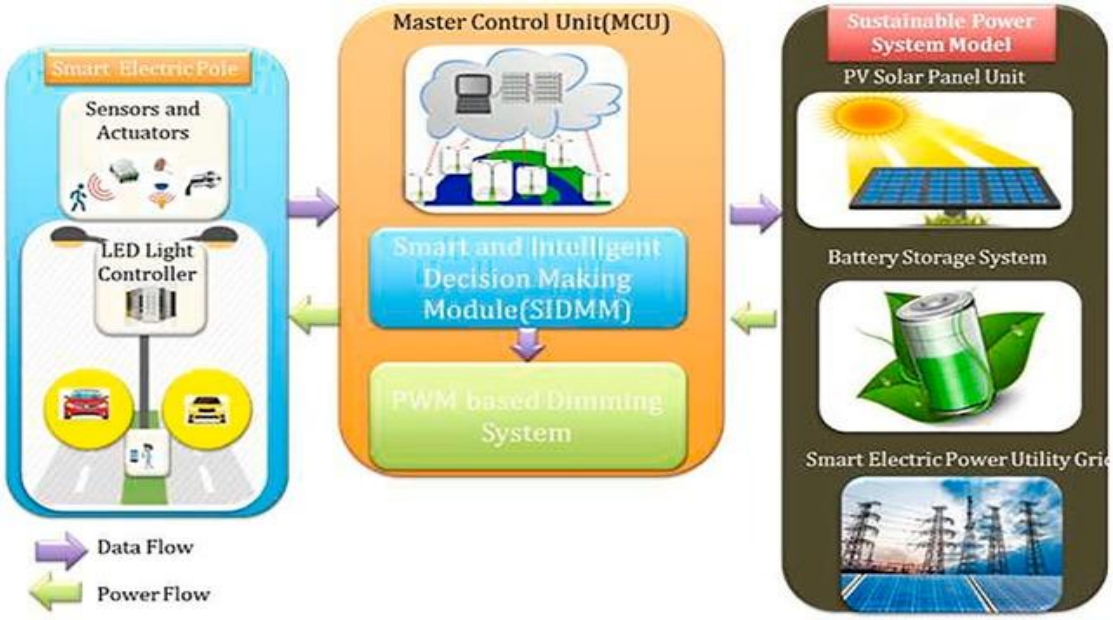

Figure 11. Proposed flow of energy efficient smart and intelligent street road lighting system [15]

The information and energy flow of the proposed sustainable energy efficient smart street road lighting system (EESSRLS) is depicted in Figure 1. It consists of a smart electric pole that transmits light and motion information via sensors and actuators to the Master control unit (MCU), which computes intensity based on this information and tunes the LED lamps using a PWM-based dimming system via a smart electric pole-mounted LED light controller (LLC). We utilize a separate sustainable power system for energy made up of a PV solar panel, battery storage system, and intelligent electric utility grid [15].

3. Results and discussion

The following table shows the comparative study of the different methods used for IoT-based smart cities:

Sr.No.	Methods	Components	Advantages	Disadvantages
1	Smart street lighting System using IoT.	LDR, LED, Smart Sensors, Arduino nano, Lightning pole.	Automatic Switching of Street lights.	More Energy Consumption.
2	An illustration of an IoT-based smart city.	Arduino Nano, LDR, IR Sensors, LED, Buzzer, Ultrasonic Sensor, Dustbins.	Less crime.	Security and data privacy concerns.
3	System Architecture of smart parking system using IoT.	Arduino Nano, Cloud, IR Sensors, Parking Slot, LED, Lamp.	Decreased management costs and reduced pollution.	It very well might be a piece mistaking for new clients.
4	IoT Potential Applications for Smart Cities.	Arduino Nano, LDR, IR Sensors, LED, Buzzer, Ultrasonic Sensor, Dustbins, Cloud.	Better transportation service and safer communication.	Security concerns and data privacy concerns.
5	IoT based interconnections.	Smart Sensors, Arduino nano, Lightning pole.	Minimize the human work and effort.	Highly dependent on the Internet.
6	Internet of things Schematic showing of the system architecture.	LCD, LDR, Signal Generator, Internet, Database, Server, Street light.	Smart cities are technology-driven, and most decision making	It starts in homes where you may suffer from a lack of privacy.
7	Smart parking system using IoT technology.	Arduino Nano, IR Senso.rs, LED, Parking Slots.	Cost and time efficient solution.	Availability of the space could be found only after the car enters the parking slot.
8	The architecture of a wireless sensor node	Power Supply, Sensors, Transceiver, Microcontroller, ADC.	Reduced cost of in-house IT management.	Increased costs for data or service migration and integration.
9	Sensor's deployment and smart systems data generation	Aggregator, Water System, Vehicular Traffic, Front Screen, Sensors, Temperature.	Creation of safer communication.	Significant capital investment in technology is required.

Sr.No.	Methods	Components	Advantages	Disadvantages
10	Conceptual representation of an urban IoT network based on the web service approach	WAN, Control Center, Gateway, Web Fronted, Database Manager.	Automatic and efficient urban management.	Considerable increase in electronic waste.

The method of IoT based smart cities are displayed in the above table. In smart street lightning system using IoT streetlights are automatic switching of. More energy consumption in this method. An illustration of an IoT based smart city method help for less crime. To decreased management costs and reduced pollution system architecture of smart parking system using IoT method developed. There are several applications of an IoT based smart city that are explained in IoT potential applications for smart cities.

IoT based interconnections minimize human work and effort. Internet of things schematic showing of the system architecture method are technology driven and most decision making. To reduce the cost of in-house IT management the architecture of a wireless sensor node method is used. Smart parking systems using IoT technology method is solution to reduce time and humans' effort as well as the overall cost of the fuel burnt in search of the parking space. The main idea is the creation of smart parking using the internet of things and ultrasonic sensors, where available parking places display in web application.

4. Conclusion

The IoT-based smart systems are integrated for city data creation for next-generation Super City planning. As demands and trends have changed over time, so have concepts of urban development. Because of the continual creation of cutting-edge innovations, the wise city is becoming brighter than it was in the past. Smart urban communities are equipped with various types of electronic equipment used for certain purposes, such as cameras in a checking framework and sensors in a transportation framework. A clever city is a complex setting defined by the increased use of information and communication technologies (ICT), planning to make urban areas more appealing and useful, and fascinating locations for development. A smart city is a place where data and communication innovations are used to boost functional productivity, communicate information with the general public, and work on the makeup of both taxpayer-driven organizations and local government support. The methods of smart city concepts include master planning, smart buildings, smart energy, smart water and waste management, smart mobility and transit, smart lighting, and cybersecurity. The greatest method for developing thoughts for smart city design is always master planning.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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