Impact of Internet of Things Applications in Smart Villages

Prashant Kumar Sinha[1,*,†], Md. Amir Khusru Akhtar[1,†] and Ashwani Kumar[2,†]

[1]*Usha Martin University, Ranchi, India*
[2]*Sharda University, Greater Noida, India.*

Abstract
The Internet of Things (IOT) has made a momentous appearance in smart city technology, which aids in the delivery of value-added administrations to various properties in the city and to individuals. Like smart cities, smart villages require more time to achieve future economic growth, increased agriculture, improved health, and enhanced education. The smart village is a concept that uses the digital revolution to improve traditional rural features. This review paper explores the profound impact of Internet of Things (IOT) applications in smart villages, aiming to enhance traditional rural features through the digital revolution. The paper delves into the core concept of smart villages, encompassing Smart Ration Distribution System, Smart Cattle Feeding System and Smart Diary Distribution. It further discusses the pivotal role of IOT in agriculture, emphasizing Smart Irrigation Systems and Climate-based Sensing House. The paper presents how IOT revolutionizes education, enumerating major advantages in this context. Additionally, it explores IOT application architecture, challenges faced by IOT, and highlights future technologies related to IOT. Smart villages, akin to smart cities, aspire to achieve economic growth, improved agriculture, enhanced health, and superior education. Embracing IOT applications empowers smart villages and fosters sustainable development, bridging the rural-urban divide and transforming rural landscapes for the better.

Keywords
IOT, application of IOT, smart village, smart town, RFID

1. Introduction

The creation of smart cities has become a priority in a worldwide trend in the area of urban planning. Smart city development attempts to improve bureaucratic efficiency by using the bid of ICT (Information and Communication Technology) organization and amenities as subsidiary factors or enablers, as well as help communities thrive [1]. A smart city is one that uses ICT and further approaches to advance the quality of life, competence of urban facilities, competitiveness, and sustainability [2].

The Internet of things (IOT) is a global network comprising trillions of objects acquired from the physical environment across the world, disseminated or promoted widely by the Internet, and finally delivered to end-users [3]. Their goal is to create an extensive network made up of various intelligent gadgets that allow data to be shared about global events at any time and

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*Corresponding author.
†These authors contributed equally.
prashantsinharanchi@gmail.com (P. K. Sinha); amir@umu.ac.in (Md. A. K. Akhtar); ashwani.kumarcse@gmail.com (A. Kumar)

from anywhere. Its operation is based on a blend of online, ICT and mobile. It enables different strategies in a system to interconnect and interrelate with one another in order to complete tasks in a coordinated manner [4]. The world's growing population necessitates making it easier for cities and villages to run efficiently. IOT will be the essential communication technology in the future. It is imperative in the concept of smart cities and villages. RFID, Cloud Computing, and other IOT advances are examples of such breakthroughs. RFIDD is the abbreviation for Radio Frequency Identification. It's given out to identify labels on various things. Its main idea is to produce a massive system made up of numerous shrewd devices and systems in order to make global information allocation easier from any location and at any time [5]. In IOT, wireless sensor networks (WSN) are also utilized to transfer data [6]. Cloud administrations provide data warehousing and calculating systems and assets that are integrated into the WSN. The Internet of things mechanism leads to the revolution of smart cities. IOT has wide range of applications such as in self-monitoring, agriculture, hospitality, health and many more as shown in the concept presented in fig. 1 proposes a simple and effective method of incorporating IOT technology into everyday life in modern villages and cities by bringing this technology into all occupations. The Internet connects traditional devices such as computers and mobile phones. Similarly, the Internet of things connects all potential gadgets that can be categorized as smart gadgets. These gadgets, as mentioned above, will interact with one another and carry out the operations as needed. Massive efforts have been made in India, where most of the population lives in villages, to automate tedious and mundane chores in city homes and offices. However, there has been very little done in towns where the IOT may play a critical role in bringing' smartness' to everyday village operations.

Figure 1: IOT based application for smart villages and cities.

The rest sections of the paper are organized as follows. Section 2 talks about core concept of smart village. Section 3 discussed about the role of IOT in agriculture. Section 4 presents revolutionizing education with IOT. Section 5 discusses IOT application architecture. Section 6 discusses challenges of the IOT. Section 7 highlights IOT related future technologies. Finally, Section 8 concludes the paper.

2. Smart Village Core Concept

The percentage of individuals who live in cities is extremely high. As a result, researchers and governments are putting out their best efforts to create smart cities in autonomous and advanced technology methods. The concept of villages can be implemented in the same way. The life of villagers will be more challenging than that of their city counterparts. The obligation to raise the bar in terms of quality of life in villages and towns is critical. Some smart city concepts can be used to help better the lives of those who reside in remote areas [7]. For example, we can utilize digital cameras and sensor devices for road surveillance and other sensors in other sectors such as agriculture, health care, electrical appliances and household appliances, and other smart living gadgets [8]. The initial phase entails identifying all devices that must communicate with one another and work simultaneously. After the first step is completed, a huge number of switches, sensors, buttons, security cameras, and specific fixed equipment for emergency purposes will be installed. Both sensors and gadgets connect to create large amounts of data, recorded and analysed on cloud servers. Big data analytics is a concept that encompasses tools such as Hadoop that research data in order to make possible use of it. Smart houses, smart agriculture, innovative education, intelligent weather systems, and monitoring systems are among the key goals of the IOT on smart towns idea.

2.1. Smart Ration Distribution System

PDS (Public Distribution System) is also known as ration distribution system, and it is one of the most frequently contested problems that is implicated in the fraud. The Indian PDS provides rice, ragi, wheat, and cooking oil to people living below the poverty line (BPL) monthly. For decades, the country's public ration distribution centres have operated under the traditional method. Due to manual intervention, this current system is prone to pilferage, malpractices, and infructuous chores, despite its virtues. The proposed digitalization of the system and automation of the distribution method in this study could be a blessing to both PDS (Public Distribution System) employees and ration-card holders, who are the beneficiaries. The Smart Ration Card is a substitute for the traditional ration card, which the government typically uses to provide food grains and other goods at a reduced cost to a designated group of individuals in society.

The RFID (Radio Frequency Identification)-based programmed rationing store is a novel innovation in the PDS that benefits ration distribution by being more efficient, exact, and robotic. An enhanced PDS technique is an RFID-based system that is accurate, automated, and efficient for ration distribution using the AADHAAR card number. The suggested automated rationing system is based on RFID technology, which allows an RFID tag to replace the old ration card. Customers' data is already saved on a government-supplied ARM microprocessor. The RFID tag must be scanned into an RFID card reader by the customer. Following a successful biometric check, the customer must use a keypad to enter the material type and quantity [9]. A correct amount of food grains is distributed, and an SMS (Short Message Service) notice is sent to the customer's mobile phone number via the GSM module as soon as the ration is supplied (Global System for Mobile Communication). Using IOT, the ARM micro-controller continually refreshes its database on item availability and details on digitized transactions.

2.2. Smart Cattle Feeding System and Smart Diary Distribution

It's time to feed the animals. It's a simple statement, but one that every cattle producer understands. The concept of an autonomous cattle feeding system came into existence to make this vital activity easier for farmers. The Automatic Cattle Feeding System is a robotic feeding system that comprises a battery-powered motorized vehicle that can deliver an equal amount of feed to each animal. The feed is manually fed into the feeder, which then follows a pre-determined path until it reaches the feeding fence at a pre-determined distance, where it is placed through a sliding door. This project is helpful in an agricultural country like Nepal, where a lack of labour in cattle farming harms dairy production, to assure the exact, timely, and enough feeding of cattle of each group. The primary goal is to create an autonomous cow feeding system that goes around the fence and evenly distributes feed. With the use of a line following robot, significant advances can be made in this field. The utilization of infrared and ultrasonic sensors guarantees precise line following and accurate feed point determination. When there was a problem with the hardware, the use of the Bluetooth module helped to control and turn off the entire system. Uniformity in feed distribution can be maintained with the use of an Automatic Cattle Feeding system. Dairy farming is generally regarded as a farmer's second most significant activity. The use of sensors and cameras makes it much easier and more efficient to manage their own effort. Abrupt crises and any changes that need to be made can be notified right away, and a solution may be retrieved right away. It also aids in the preservation of appropriate temperature levels for the animals. It is possible to provide enough food, water, and other components for the cattle. People will find it easier to use such innovative technologies because everything is done automatically by the gadgets and does not require human participation.

3. The Role of IOT in Agriculture

Agriculture uses IOT to obtain insights and monitor farms using robots, drones, sensors, and computer imaging combined with analytical tools. Farmers must get the most significant benefits from the IOT and Smart Villages networks because agriculture is considered a pillar of all villagers. It is necessary to track product from the farm to the table. Meaningful Data gathered from sensors and other sources can be used to monitor and improve the entire chain of activities. Growers, processors, packers, and storage, distributors, wholesalers, retailers, and transportation service providers are all involved in the process [10]. There are a variety of factors that contribute to this; it could be due to water waste, low-slung soil richness, compost handling, environmental modification, or illnesses are few examples. In agribusiness, successful mediation is critical, with IOT as a solution in conjunction with radar systems. It has the latent to stir up the way agribusiness is improved, and it demonstrates a strong commitment to making farming more sustainable. Physical devices placed on farms which is used to monitors and collects data, which is then used to gain insights. Farmers may observe on their crops using an analytical web based dashboard and take action based on their learning. Data gathered from sensors and crop leaf photos recorded by remote networks can be used to anticipate agricultural diseases and insecticides. Farmers can use their cell phones to acquire up-to-date information. Alert systems can be activated in the event of an emergency and provide immediate assistance. Consider a wheat crop that is about to be harvested: a single spark might ignite the entire field, causing massive forfeiture to the farmers.

Environmental sensing device can identify smoke at the earliest hint of a fire, triggering water sprinklers to immediately extinguish the flames and prevent catastrophic loss. Sensors can also monitor the ripeness of fruits and vegetables and warn transportation facility providers to minimized delays. Three-level of structure underpins the Internet of things. It has three layers: observation, arrangement, and application. Sensor bits are used in the recognition layer. Sensor bits and data interchange technologies, such as ICT-enabled gadgets, are the foundations of sensor innovation. After then, reasonable arrangements for selling the produce on the market may be formed.

3.1. Smart Irrigation System

Personal engagement of people, primarily farmers, is typical of the current irrigation system in a village at every stage of demand assessment and operation of electric motors/pumps. Perfect weather forecasts will be highly beneficial in the communities, as they will develop their crops based on the information provided. As we all know, the majority of people in villages make their living by working in agriculture. Farmers employ environmental sensors to provide information on weather forecasting and which fields should be cultivated according to the season. These ecological sensors will allow towns to rely on farming to a great extent. Irrigation, sowing, and harvesting are vital agricultural activities that are now dependent on weather predictions. Sensors are particularly useful in the sector of agriculture, where smart irrigation systems [11] are used. Remote satellite data can ensure the most efficient use of water resources. Facts from recent climate occurrences can help agriculturists plan for a prosperous agricultural generation. Radio broadcasts, television, daily newspapers, and cell phone voice messages provide ranchers with climatic data and alerts. Ranchers can use index-based protection plans to shield themselves against the risks associated with fluctuations in precipitation and temperature throughout various stages of trim development [12].

Crop Observation: Sensors installed in the farms monitor changes in shape, light, humidity, temperature and size. Sensors notice any anomalies, which are analyzed and the Farmer is notified. As a result, remote sensing can aid in disease prevention and crop growth monitoring.

Climate Conditions:

Sensor data on temperature, humidity, moisture precipitation, and dew detection help farmers determine the weather pattern so that the right crops may be grown. For example, A temperature sensor is a piece of equipment that measures temperature using an electrical signal, generally a thermocouple or RTD (Resistance Temperature Detector). A thermocouple (T/C) is a device that produces an electrical voltage proportional to temperature changes and is made up of two dissimilar metals.

Humidity devices detect and quantify comparative gumminess in the air, as well as wetness and air temperature moistness, which is defined as the percentage of genuine wetness in the mid-air to the utmost notable amount moisture which could be kept at ambient temperature. Humidity has a direct effect on a plant's water relations and, in turn, has an indirect impact on leaf development, photosynthetic combination, fertilization, and, finally, practical yield [13].

Quality of the Soil:

Soil quality study aids in evaluating nutrient value and drier portions of farms and soil drainage capacity and acidity, enabling for irrigation water requirements to be adjusted and the best kind of cultivation to be chosen. On a volumetric or gravimetric basis, the amount of water in a medium, such as soil, is monitored by a soil moisture sensor. In order to attain a precise result, sensor capacity to monitor soil temperature sensor is also necessary for standardization [14].

3.2. Climate-based Sensing House

A Climate-Smart Village's site is determined by its climate risk profile, alternative land use possibilities, and farmers and local government's desire to participate in the development [15]. The Atmosphere's Success The people of Keen Town are essential to the town's success. CCAFS organises or partners with existing groupings of cultivators, researchers, rural agro-counselling specialised cooperatives, and local governments to address environment change, farming, and nutrition safety. They are trained on the boxes of atmosphere smart village and encouraged to legally register with the administration (if they haven't already) in order to receive government plan benefits. The town's chief collaborator picks a site organiser and assistant to provide specialised advice and liaise with CCAFS asset individuals [16].

The IOT's Immediate Potential For Lowering Carbon Emissions

The Environmental organization, a global non-governmental organization, lobbies for extensive changeover to LED illumination, particularly in common areas and for road lighting, in order to decrease carbon discharges by 1.4 million tons per year. The Outdoor Lighting Accelerator initiative of the US Department of Energy, which provides technical assistance, financial, and regulatory help, supports these goals. Industrial IOT has the potential to significantly reduce the carbon footprint of processes. It accomplishes this by conserving natural resources such as raw materials, power, fossil fuels, and water. In addition, the technology can help reduce industrial waste and play a crucial role in the growing circular economy's material flow tracking.

The Internet of Things' Contribution to Carbon Compliance And Governance

In the drive to extend carbon monitoring and taxes, IOT sensors will become increasingly vital. As of now 15% of carbon emissions are priced and taxed, according to the UN Climate Action Sustainable Innovation Forum, and the group plans to swiftly grow. Regulators have traditionally struggled to enforce anti-pollution measures. The moral update is that in the twenty-first century, climate-focused public-private partnerships have grown in popularity. Large-scale climate change programs have seen growing participation and cooperation from businesses, municipal governments, and non-governmental organizations (NGOs). For example, some sensors with air quality sensors coupled to a smart lighting grid in a metropolitan area might provide these bodies with constant and reliable monitoring and real-time reporting of actual carbon emissions and other damaging activities at carbon reduction sites.

4. Revolutionizing Education with IOT

4.1. Smart Education system

Education is the foundation for all other accomplishments in life. It is easier to implement new technology if people are educated about how to use them. It could be the catalyst for reducing the digital gap, which is much worse in rural areas than in cities. The entire Smart town concept revolves around the inhabitants and how well they utilize the Smart village's components. They can be taught to participate in all of the activities in the community, resulting in a greater quality of life for the residents. The Internet of Things (IOT) connects various machineries such as the mobile phones, connected with internet and smart devices to aid learning. Children and even adults can benefit from the usage of LCD panels and interactive films to help them learn. These can be used to teach people how to make the best use of the Smart village's amenities. Village schools can be equipped with the Internet and other gadgets, making studying a fun activity and transforming them into Smart schools [17].

IOT In The Classroom Increases Student Productivity

Mary Claire Wright, a instructor at Davidson High School in Mobile, Alabama, imparts computer science, spoke about how she has enjoyed via Igor's IOT podium in her schoolroom and through the school. Wright described how she customs IOT-enabled striking situations to alter the brightness, warmth, and coolness of the lights in her classroom. These minor adjustments aid in refocusing kids' attention.

Using IOT Applications In Schools To Keep Students And Teachers Safe

In the event of an intruder, the institute is also outfitted with firing covering equipment, and IOT-connected gadgets such as electronic and colored lights show promptly inform kids, supervisor, and local authorities. Other emergency measures, such as extreme weather concerns, are programmed into the Igor-powered security system. Different settings in the school cause different alarms, but the inclusive result is an innocuous education atmosphere for toddlers and operator.

4.2. Major advantages of IOT in education

Using IOT Technology to Make Schools Safer

Associated devices such as colored lights, digital signs, sensors and door lock scan be used with IOT networks to create customizable security strategies. Some schools employ an IOT network to develop various programs in response to harsh weather, impostors, and other refuge threats. IOT skill also allows results in the classroom, such as integrated alternative fright switches. Teachers may use IOT security tools to take entertainment and keep their pupils secure [17].

IOT Applications Improve Student Outcomes

Fluorescent lighting, which is commonly seen in classrooms, has been proved to have a adverse effect on school child concert in studies. Connecting programmable IOT-connected LED light in a tutorial room is impartial one technique to advance the apprentice knowledge.

IOT in Schools Improves Energy Efficiency and Saves Money

Igniting and other IOT-connected appliances can be involuntary and computerized. Lights, designed for example, can be programmed to turn on and off on a timetable or be linked to occupancy detectors and when a classroom is vacant, the lights are turned off. IOT connectivity improves building competence and reduces energy surplus, consequential in cost savings.

5. IOT Application: Architecture

IOT architecture is a collection of multiple parts that include anything from sensors and protocols to actuators and cloud services, as well as layers and layers of cloud services. In addition to devices and sensors, the IOT architecture layers are unique in that they track the consistency of a system through protocols and gateways, which is a feature of the Internet of Things. Researchers have proposed a variety of different architectures, and we can all agree that there is no one consensus on architecture for the IOT. Three-layer architecture is the most fundamental type of building. The perception, network, and application layers are the three separate levels that make up the system.

In the perception layer, there are sensors for perceiving and gathering information about the environment. This is the physical layer of the computer system. It detects certain physical properties or recognizes other intelligent items in the surrounding environment.

The network layer is in charge of establishing connections with other smart things, network devices, and servers, among other things. Moreover, its properties are employed in the transmission and processing of sensor data.

In terms of delivering application-specific services to users, the application layer performs admirably well. It describes a number of different applications in which Internet of Things services can be implemented, such as smart homes, smart cities, and smart health.

Even though the three-layer architecture explains the core concept of the IOT, it is considered insufficient for study since in-depth analysis often focuses on other finer features of the IOT, according to some experts. As a result, a five-layer architecture such as Business layers, Application layers, Processing layers, Transport layers, and Perception layers was proposed, which comprises the processing and business layers in addition to the presentation layer [**?**]. Fig. 2 shows the block diagram that outlines the five layers of the IOT application architecture.

As the name implies, the transport layer is responsible for the majority of the data transfer from the perception layer to the processing layer and vice versa. This transportation is mostly accomplished using networks such as SDN/NFV, 5G, Wi-Fi, local area networks, RFID, Bluetooth, and NFC, among other technologies and networks. In addition to storing, analyzing, and processing massive volumes of data, the processing layer is also known as the middleware layer. It receives data from the transport layer. It has the ability to govern and give a diverse range of services to the lower layers. It makes use of a variety of technologies, including cloud computing, databases, and big data analytics, among others. The business layer is responsible for the overall management of the Internet of Things system, including profit models, apps, and enterprises.

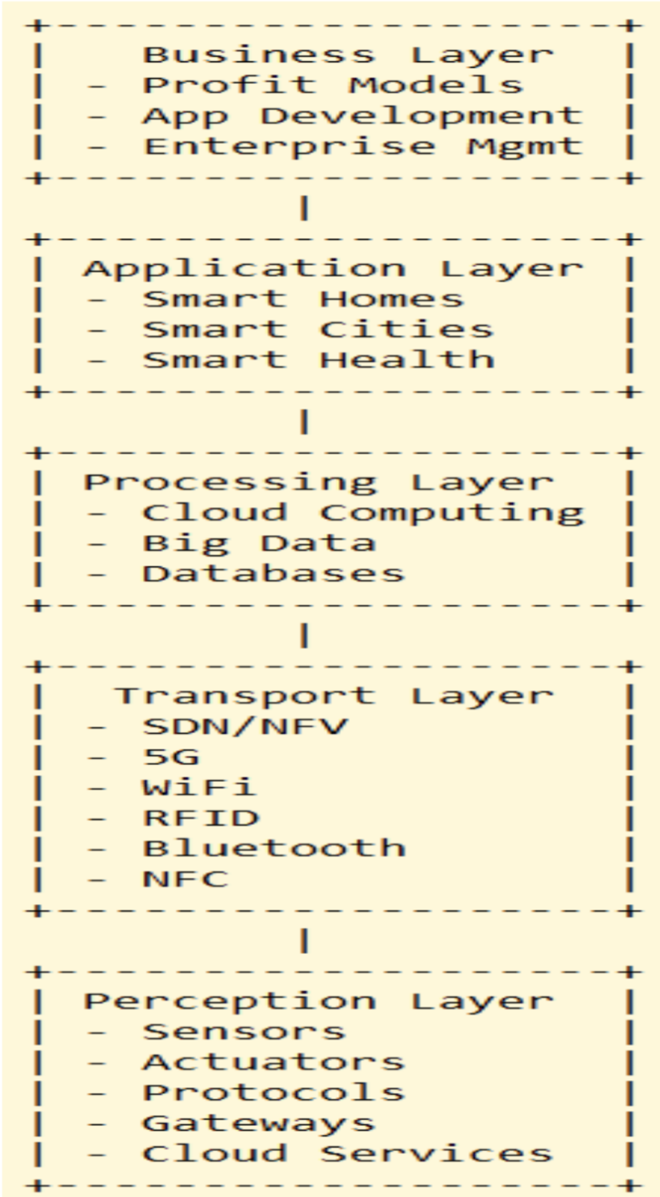

Figure 2: IOT Application Architecture with its five layers.

6. Challenges of the IOT

Although the IOT applications and conditions deliberated above are very enthralling and stretch skill for smart the whole thing, there are positive sprints to the Internet of Things idea's bid in terms of price of operation. The expectancy that the technology must be economical and valid to a vast number of things. IOT also faces a slew of other issues, including:

Interoperability:

In the Internet of Things, diverse the types of smart things that have different processing, information, and communication capabilities [?]. Different circumstances, such as energy accessibility and infrastructures bandwidth requirements, would be functional to different smart items. Common ideals are indispensable to endorse communication and collaboration among these stuffs.

Wireless communications:

UMTS, Wi-Fi, GSM, and Bluetooth are the different established wireless technologies which are unproductive in terms of energy use; newer WPAN standards such as ZigBee and others still in expansion may have a slenderer bandwidth, but they require substantially less power [?].

Data interpretation:

To support smart element operators, it is essential to understand the local context resolute by devices as exactly as conceivable. Facility bread winners must be able to make generalizable extrapolations from the construed sensor information in order to revenue from the dissimilar data that will be shaped.

Scalability:

Because things work together in an uncluttered atmosphere, the IOT has a much bigger impression than the outdated Net of CPUs. As a result, rudimentary structures like service detection and communication must slog similarly well in both small- and large-scale circumstances. IOT in order to get a benefit, added roles and approaches are obligatory. Scalability necessitates well-organized process [?].

Power Supply:

Power supply isn't always connected to things move around us; their intellect must be motorized by a self-reliant energy basis. Contempt the statistic that inactive RFID transponders do not need their individual control unit, their operative and communication assortment are harshly controlled. Forthcoming low-power CPUs and communications elements for fixed systems are predictable to save a huge quantity of energy. Energy maintenance is a deliberation not just in ironware and organization planning, but also in software, such as procedure heap expansion, where each broadcast byte must defend its reality.

Self-Organizing:

Nifty things should not be achieved in the same way that computers are, with users organizing and familiarizing them to precise circumstances. Mobile items, which are characteristically only utilized on an unbalanced base, must be able to create networks on their own, as well as position and organize themselves to outfit their atmosphere.

Data Volumes:

Approximately IOT bid scenarios may need rare statement and data gathering from device nets, large-scale networks, and logistics, massive amounts of data will be collected on central network nodes or servers. Big data is the term used to describe this phenomenon, which necessitates a variety of operational mechanisms in addition to new technologies storage, management technologies and processing [?].

7. Future Technologies challenges of the IOT

Numerous novel skills are related with IOT to demonstrate the incorporation of reinforced and wireless switch, statement, and IT technologies, which are accountable for linking multiple subsystems and things that function under a intelligently regulated and managed unified platform. Use of IOT in developing healthcare applications [18] and secure decentralized applications [19, 20] are becoming popular.

Big Data: Due to today's rapid network expansion, the number of devices and sensors in networks is increasing in physical settings, causing information communication networks, services, and applications in numerous areas to alter [**?**]. The Internet of Things is a term used to describe the technologies and solutions that enable the integration of real-world data and services into current information networking technologies (IOT). The volume of data on the Internet and the Web continues to expand; around 2.5 quintillion bytes of data are created every day, and it is believed that 90 percent of the data today is created on the Internet and the Web today was produced in the past two years. Sensory data such as expected and balanced power consumption in analyzed pollution, weather, smart grids, and sensory data recorded and traffic data, to progress traffic controller and organization, and intensive care and processing health indications are all examples of sensory data. Data gathered by sensory devices in order to improve healthcare services.

Distributed Computing: Cloud computing is the result of a large number of distributed computing technologies combined with service-oriented architecture, independent, hardware virtualization, and efficacy computing. Distributed computing entails the employment of a collection of connected computers to achieve a single computational purpose. As all three falls under the scientific computing umbrella, distributed computing has a number of challenges in common with concurrent and parallel computing. Physical things are no longer isolated from the virtual world; they may now be controlled remotely and used as physical access points for Internet services [**?**].

Cloud Computing: The cloud can provide a cost-effective option for managing and composing IOT services, as well as building claims and facilities that feat the items or statistics shaped by the system. On the contrary, Cloud can assistance from IOT by mounting its possibility to pact with practical matters in a more dispersed and energetic way and transporting new facilities in extensive choice of real-world situations. The two ecospheres of Cloud and IOT have changed at a fast and discrete pace. These ecospheres are massively dissimilar, yet their potentials are regularly balancing in overall, with IOT promoting from the cloud's almost boundless aptitudes and possessions to recompense for its scientific restrictions in packing, handing out, and statement. Cloud permits IOT claims to permit information to aggregation and data dispensation and fast arrangement and incorporation of dissimilar possessions while keeping positioning and complicated data processing costs low. The cloud can serve as an intermediary layer between items and applications, obfuscating all of the difficulty and functionality required to fix the latter. This will influence forthcoming application progress since data collection, dealing out, and communicate will present new issues, particularly in a multi-cloud or fog cloud environment.

Security and Privacy: Since it is essential to express faith to humans and is resilient sufficient to be cast-off by technologies deprived of denial of facility, the trust framework must cope with humans and machines as users. Advances in lightweight public key infrastructures (PKI) as a foundation for trust management will be required to design trust frameworks that satisfy this requirement. For IOT-based systems to assess trust in people, devices, and data, new methodologies are necessary. The most well-known ways are faith concession, which consents two revelries to inevitably exchange the minimal level of hope vital to permit access to a deal or a piece of data based on a chain of trust policies.

8. Conclusions

Smart villages were formerly thought to be a futuristic and difficult concept, but they are now a reality. The entire credit for progress goes to the ever-evolving technology that has been deployed. The main issues in these villages revolve around a lack of a robust open transportation framework, crisis administrations, and a lack of understanding of how to approve appropriations for country zones. Our idea is to expand Smart Cities to Smart Villages by leveraging current innovative inclinations and paying more attention to the challenges that these rural areas face. The most widespread application of such technologies may be found in villages, where people tend to put in a lot of effort and time that might be done in their absence by smart technology already in place. We've also looked into a number of other aspects of the IOT and made recommendations based on our findings.

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