IoT for Future Technology Augmentation: A Radical Approach

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ABSTRACT

Known as the Internet of Things (IoT), it is a new paradigm that has transformed a traditional way of life into a high-tech way of life. Smart cities, smart homes, pollution management, energy conservation, smart transportation, and smart industries are all examples of transformations brought about by the Internet of Things. A large number of important research studies and investigations have been carried out in order to improve technology through the Internet of Things. However, there are still a slew of obstacles and issues that must be addressed before the Internet of Things can realize its full potential. These challenges and issues must be evaluated from a variety of perspectives related to the Internet of Things, including applications, challenges, enabling technologies, social and environmental implications, and so on. In this review article, the primary purpose is to present an in-depth discussion from both a technological and a sociological standpoint. The article examines the various obstacles and critical issues associated with the Internet of Things, as well as the architecture and important application domains. Additionally, the essay brings to light the existing literature and illustrates their significance to many parts of the Internet of Things. Furthermore, the significance of big data and its analysis in relation to the Internet of Things has been highlighted. This article will assist readers and researchers in better understanding the Internet of Things (IoT) and how it might be applied in the real world.

Key words:
Internet of Things (IoT), IoT architecture, Future Technology, Technology Boosting, IoT Applications

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INTRODUCTION

The Internet of Things (IoT) is a new paradigm that allows electronic gadgets and sensors to communicate with one another over the internet in order to improve our quality of life (Adusumalli, 2016a). The Internet of Things (IoT) makes use of smart devices and the internet to deliver new solutions to a wide range of challenges and issues relating to various business, governmental, and public/private industries around the world. More than that, it makes use of quantum and nanotechnology in order to achieve storage capacities, sensing capabilities, and computing speeds that were previously unthinkable (Pasupuleti, 2016b). In order to demonstrate the potential usefulness and applicability of IoT changes, extensive research investigations have been carried out and are available in the form of scholarly articles, news reports, and other forms of printed materials, both on the internet and in printed form. It could be used as a preparatory effort before developing fresh, inventive business ideas that take into account security, assurance, and interoperability issues, among other things (Ahmed and Neogy, 2009).

With the rising engagement of Internet of Things devices and technology in our everyday routine lives, we may see a significant shift in our way of living. One example of an Internet of Things advancement is the concept of Smart Home Systems (SHS) and appliances, which are comprised of internet-connected gadgets, home automation systems, and a dependable energy management system. Another significant breakthrough of the Internet of Things is the Smart Health Sensing system (SHSS). SHSS is a collection of small intelligent equipment and gadgets that are designed to assist the health of humans. Both indoors and outdoors, these devices can be used to check and monitor a variety of health conditions, fitness levels, and other relevant data, such as the number of calories burned at the gym. It is also being used to monitor critical health situations in hospitals and trauma centers, among other places of employment. In this way, it has altered the entire landscape of the medical arena by providing it with cutting-edge technology and intelligent gadgets. Furthermore, Internet of Things (IoT) developers and researchers are actively interested in improving the quality of life for individuals with disabilities and in the senior age group.

PROBLEM STATEMENT

The Internet of Things (IoT) has demonstrated exceptional performance in this field and has provided a new direction for the daily lives of such individuals. This is due to the fact that modern technologies and equipment are far more cost efficient in terms of development costs and are readily available within a regular price range, resulting in the vast majority of people utilizing them. Thanks to the Internet of Things, they can lead a regular life. Transportation is yet another vital component of our daily lives. The Internet of Things (IoT) has brought about several new advances that have made it more efficient, comfortable, and dependable (Adusumalli, 2016b). Intelligent sensors and drone gadgets are now in charge of traffic control at various signalized junctions in key cities across the country. Additional to this, automobiles are being introduced into markets with sensing devices already installed that are capable of recognizing approaching major traffic congestions on the map and may propose a different route with less traffic congestion. As a result, the Internet of Things (IoT) offers a wide range of applications in various realms of life and technology. We may conclude that the Internet of Things has a great deal of potential, both in terms of technological advancement and in terms of facilitating humankind. The Internet of Things (IoT) is gradually becoming a significant component of our lives, and it can be felt all around us. In general, the Internet of Things (IoT) is a technological innovation that brings together a diverse range of smart systems, frameworks, and intelligent objects and sensors (Figure 1).

The Internet of Things has also demonstrated its significance and potential in the economic and industrial development of a growing region. It is also being hailed as a revolutionary step in the world of commerce and the stock exchange market.

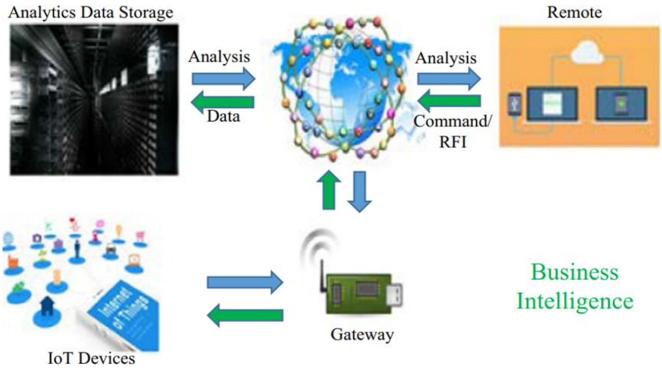

Figure 1: Overall architecture of the Internet of Things (IoT)

However, the security of data and information is a key worry and a highly desirable goal, and it is a major challenge for Begum et al. to deal with this issue effectively (2012). Due to the Internet's position as the most significant source of security concerns and cyber-attacks, it has created a slew of avenues for hackers, making data and information more vulnerable. However, the Internet of Things is committed to providing the best possible solutions to cope with data and information security challenges. As a result, security is the most pressing issue facing the Internet of Things in commerce and the economy. The construction of a secure channel for collaboration between social networks while also considering privacy concerns is a popular topic in the Internet of Things, and IoT developers are working tirelessly to achieve this goal. The following is the structure of the remaining portion of the article: The "literature survey" section will provide the most up-to-date information on significant studies that have tackled various challenges and issues in the Internet of Things.

LITERATURE SURVEY

Environmental, industrial, public/private, medical, transportation, and other fields are among those that stand to profit from the Internet of Things (IoT), according to its transdisciplinary vision. Different scholars have explained the Internet of Things (IoT) in different ways, depending on their individual interests and characteristics (Adusumalli and Pasupuleti, 2017). The Internet of Things' promise and power may be observed in a variety of application sectors. Figure 2 depicts a handful of the potential application fields for the Internet of Things. Several significant Internet of Things (IoT) initiatives have taken hold of the market in recent years.

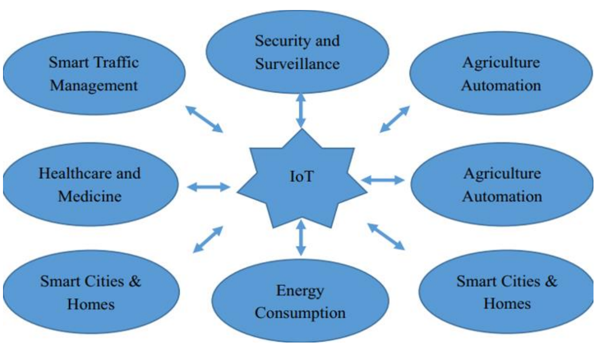

Figure 2: Some of the potential application domains of IoT

Smart city is a prominent IoT application area that includes smart homes. Smart house includes IoT equipped home appliances, HVAC, TV, audio/video streaming devices, and security systems that communicate with one other to give maximum comfort, security, and efficiency. This communication is done via an IoT-based central control unit (Pasupuleti & Adusumalli, 2018). The smart city concept has gained prominence in the previous decade, attracting much research. As a result of decreased energy use, smart homes save money on electricity bills. Smart cities also include smart cars, in addition to smart residences (Fadziso et al., 2018). Modern cars have clever electronics and sensors that manage everything from the headlights to the engine. This new smart car system will include wireless connectivity between cars and drivers to ensure predictive maintenance and a safe driving experience (Liu et al., 2012). Khajenasiri et al. (2017) studied IoT options for smart energy management in smart cities. They claim that IoT is now only used in a few sectors to benefit both technology and people. IoT has a very broad scope and will soon cover practically all application areas. They stated that IoT can help design a smart energy control system that saves both energy and money. They described an IoT architecture for smart cities. The authors also mentioned the immaturity of IoT hardware and software as a challenge. So that an IoT system can be reliable, efficient and user-friendly.

Alavi et al. (2018) tackled urbanization. People moving from rural to urban areas, increasing urban population. So smart solutions for mobility, energy, healthcare, and infrastructure are required. Smart city is an important IoT application area. It looks at smart parking, smart lighting, smart garbage collection, smart traffic management, and smart air quality control (Figure 3). They stated that IoT is working hard to address these concerns. Increasing urbanization has necessitated enhanced smart city infrastructure, allowing smart city enterprises to flourish. The authors concluded that IoT-enabled technology is critical for smart city development. Security and privacy are two more key IoT issues that demand research. Weber (2010) recommended that a private corporation using IoT should also incorporate data authentication, access control, attack resistance, and client privacy into their business activities.

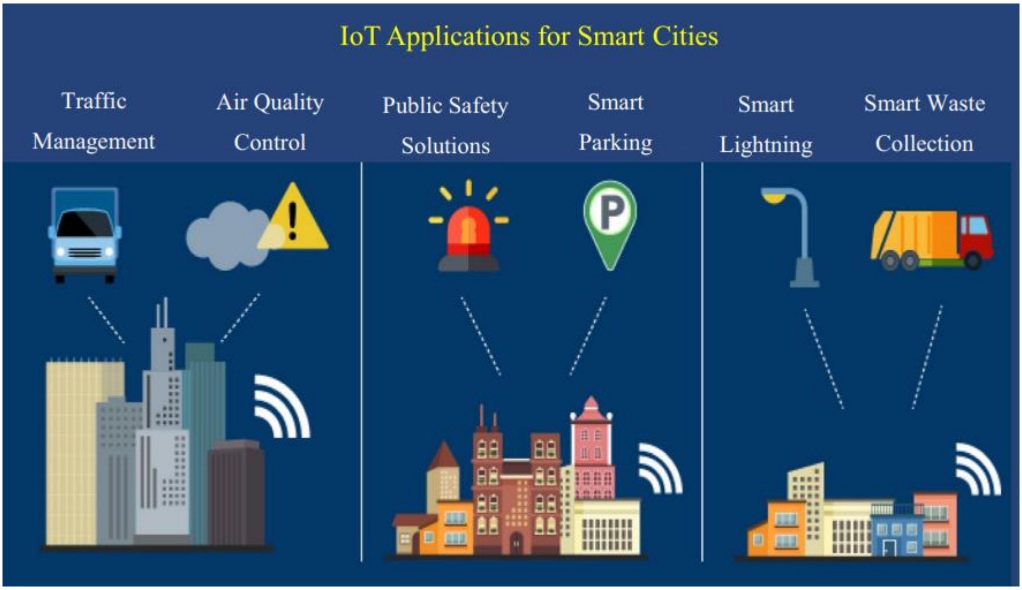

Figure 3: Potential IoT application areas for smart cities

Weber stated that while defining global security and privacy challenges, IoT developers should consider the geographical constraints of each country. A global framework for privacy and security must be designed. Before designing a full-fledged IoT framework, it is highly suggested to research and understand privacy and security issues.

A security problem was later identified by Heer et al. (2011). They stated that the internet is the backbone for IoT device connectivity. So IP-based IoT security is a major worry. Also, security architecture should include the life cycle and capabilities of each IoT object. It also involves a trusted third party and security standards. A security architecture that can expand from tiny to huge items in IoT is widely desired. The study found that because IoT has created a new means of communicating across networks, standard end-to-end internet protocols cannot handle this communication. To provide end-to-end security, new protocols must consider translations at gateways. Moreover, each communication layer has its own security concerns. Thus, satisfying only one layer's criteria leaves the system susceptible, and security should be assured for all layers. Authentication and access control are further IoT security issues that require promising solutions. Liu et al. (2012a) proposed an authentication and access control solution.

Adusumalli (2017b) emphasized the relevance of interoperability in IoT since it facilitates the integration of devices and services from various heterogeneous platforms. Several more studies emphasized the importance of interoperability and the issues it faces in IoT. Kim et al. (2015) suggested an IoT-based ecological monitoring system. Existing approaches take too long and involve too much human intervention, they said (Azad et al., 2011). A routine visit is also required to collect data from sensors installed at the investigation site. Also, some data was missing, resulting in inaccurate analysis. It may thus handle this difficulty and deliver great accuracy in analysis, prediction. They later demonstrate concern for home waste water treatment. They identified many flaws in the waste water treatment process and recommended IoT-based alternatives. IoT can be problematic in waste water treatment and process monitoring. Agriculture is a vital domain globally. Some of these elements include geography and ecology.

Qiu et al. (2013) claim that the technology employed to govern ecosystems is immature and stupid. According to Tey, IoT developers and researchers may find it useful. Qiu et al. (2013) presented a four-layer intelligent monitoring platform framework for facility agriculture ecosystem management based on IoT. Each layer performs a unique role, and together they create a better ecology with less human interference. Another major worldwide worry is climate change (Ahmed and Dey, 2009).

Fang et al. (2014) proposed an integrated information system (IIS) that combines IoT, geo-informatics, cloud computing, GPS, GIS, and e-science to provide a flawed environmental monitoring and control system. This IIS improves data collecting, processing, and decision making for climate control. Globally, air pollution is a major issue. Various methods and strategies are available to control air quality. AirCloud is a cloud-based air quality monitoring system presented by Cheng et al. They deployed AirCloud and analyzed its performance for 2 months utilizing 5 months of data.

Adusumalli (2017a) saw QoS as a difficult problem in evaluating and selecting IoT devices, protocols, and services. QoS is a key factor in gaining customer trust in IoT services and devices. They devised a novel distributed QoS selection method. This method used distributed constraint optimization and multi-agent systems. Several tests in genuine dispersed contexts were used to evaluate the concept. The IoT can also be used to improve environmental and agricultural standards. This was the focus of an IoT survey carried out by Talavera et al. (2017). They said IoT's efforts in these areas are obvious. IoT benefits farms and society by enhancing present technology. Adusumalli (2018) emphasized the value of IoT-based patient monitoring. They indicated that IoT gadgets and sensors connected to the internet can enhance patients' health. They also proposed a structure and protocol.

IoT Architecture and Technologies

The Internet of Things architecture is comprised of five critical levels that define all of the functionality of IoT systems in detail (Pasupuleti, 2016a). Perception layer, network layer, middleware layer, application layer, and business layer are the layers that make up the OSI model. The perception layer, which is at the foundation of the Internet of Things architecture, is comprised of physical devices such as sensors, RFID chips, barcodes, and other physical things that are connected to the IoT network. When these devices acquire information, they are preparing it for delivery to the network layer. The network layer serves as a transmission medium for information that is delivered from the perception layer to the information processing system through the network. This transmission of information may take place through any wired or wireless medium, including 3G/4G, Wi-Fi, Bluetooth, and other similar technologies. On top of the architecture is a business layer, which is in charge of controlling the overall Internet of Things system, as well as its applications and services. The business layer presents information and data obtained from the application layer in a visually appealing manner, and it uses this information to develop future aims and plans. Furthermore, IoT designs can be tailored to meet specific requirements and to specific application domains.

There are various critical functional blocks that are responsible for I/O operations, connectivity difficulties, processing, audio/video monitoring, and storage management, among other things. All of these functional blocks work together to produce an efficient Internet of Things system, which is critical for achieving peak performance. Despite the fact that numerous reference architectures have been offered along with technical requirements, these are still far from the standard architecture that is suited for the global Internet of Things. A viable architecture that can meet the needs of the global IoT is therefore still need to be developed. Figure 4 depicts the general operating framework of an Internet of Things system. Figure 4 depicts the relationship between the Internet of Things and specific application parameters. IoT gateways play a critical role in Internet of Things communication because they enable connectivity between IoT servers and IoT devices that are used in a variety of applications.

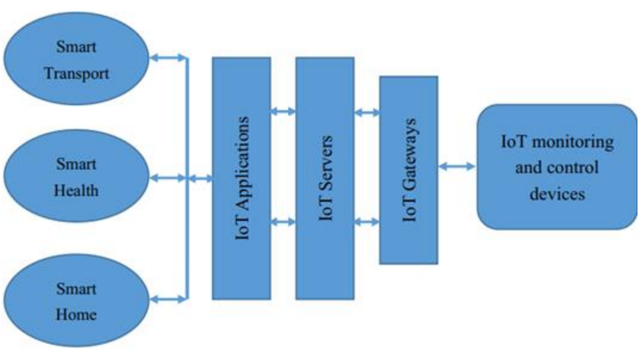

Figure 4: Working structure of IoT

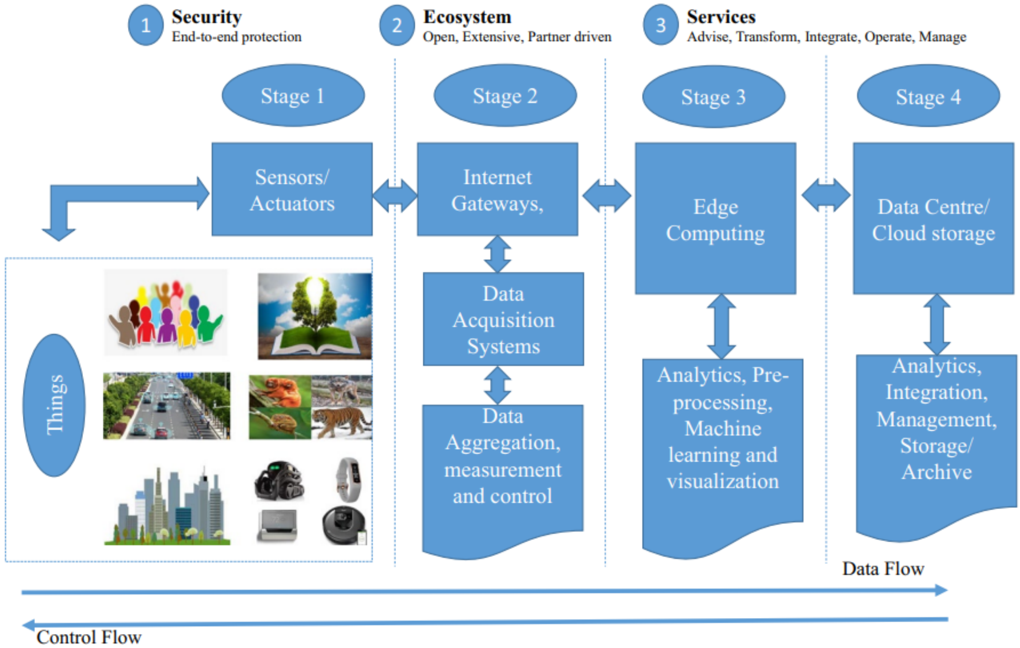

Figure 5: Four stage IoT architecture to deal with massive data

These are the key design concerns for an efficient IoT architecture in a heterogeneous context. The IoT architecture must be built to support cross-domain interactions, multi-system integration, simple and scalable management, big data analytics and storage, and user-friendly applications. The architecture should also be able to bring intelligence and automation to the IoT devices in the system.

Moreover, the growing volume of huge data generated by IoT sensors and devices is a new difficulty. Because of this, IoT systems require a very efficient architecture. Cloud and fog/edge computing are two common IoT system topologies that handle, monitor, and analyze massive amounts of data. As depicted in Figure 5, a modern IoT design has four stages.

Sensors and actuators are key in stage 1 of the architecture. The real world includes humans, animals, electrical devices, smart vehicles, and buildings. Sensors collect data from these real-world items and convert it into data that can be analyzed. Actuators can also intervene in reality, e.g. control room temperature, vehicle speed, music and light. Stage 1 collects data from the real world for subsequent processing. Stage 2 works with sensors, actuators, gateways, and data collecting systems. The huge volume of data created in stage 1 is gathered and optimized for processing in this stage. So after stage 2 (aggregation and structuring huge data) comes stage 3 (edge computing). Edge computing is an open architecture that permits the use of IoT technologies and vast computing capacity from anywhere in the world. For IoT systems, it provides a strong solution for streaming data processing. Stage 3 edge computing solutions deal with huge amounts of data and include features like visualization, data integration, and machine learning analysis. The final stage includes detailed processing and analysis, as well as delivering feedback to increase the system's precision and accuracy. This is all done on a cloud server or data center. Machine learning approaches can be used to generate better prediction models which could help in a more accurate and reliable IoT system to match the current demand.

IMPORTANCE OF BIG DATA ANALYTICS IN IOT

An Internet of Things system is made up of a large number of connected devices and sensors that communicate with one another. The number of sensors and devices is fast expanding as a result of the vast growth and extension of the Internet of Things network. These gadgets speak with one another and transport enormous amounts of data across the internet (Pasupuleti, 2015a). This data is extremely large in volume and is updated on a second-to-second basis, making it eligible to be referred to as big data. Data management and collecting, data storage and processing, and data analytics are all complicated issues that arise from the continuous proliferation of Internet of Things (IoT) based networks. The Internet of Things (IoT) big data framework for smart buildings is extremely effective for dealing with a variety of smart building challenges such as monitoring oxygen levels, measuring smoke/hazardous gases, and brightness, among others. A framework of this type is capable of collecting data from sensors put in buildings and performing data analytics to aid in decision-making in real time. Furthermore, an Internet of Things (IoT)-based cyber physical system that is equipped with information analysis and knowledge acquisition methodologies might help to improve industrial production efficiency. When it comes to smart cities, traffic congestion is a major concern. Using Internet of Things devices and sensors embedded in traffic signals, real-time traffic information may be collected and analyzed in an Internet of Things-based traffic management system. IoT sensors used with patients create a large amount of information on their health condition every second, which can be analyzed for healthcare analytic purposes. This massive amount of data must be merged into a single database and analyzed in real time in order to make quick decisions with high accuracy, and big data technology is the most effective option for this task, according to the experts (Ahmed, 2012). The Internet of Things, in conjunction with big data analytics, can also aid in the transformation of old methodologies employed in the industrial industry into more modern ones. The information generated by sensing devices may be examined using big data methodologies, and this information can be used to assist in a variety of decision-making activities. Furthermore, the use of cloud computing and analytics can improve the development and conservation of energy through lower costs and increased customer satisfaction, among other things. In the Internet of Things, devices generate a massive volume of streaming data, which must be stored effectively and analyzed further in order to make decisions in real time. Deep learning is extremely adept at dealing with vast amounts of information and can produce findings that are extremely accurate. As a result, the Internet of Things, Big Data Analytics, and Deep Learning are all critical to the development of a high-tech society.

MAJOR IOT APPLICATIONS

Emerging economy, environmental and health-care

IoT is focused to bringing new public and economic benefits to society and people. This encompasses economic development, water quality upkeep, public health, industrialization, etc. Overall, IoT is working hard to achieve the UN's social, health, and economic goals. Another worry is environmental sustainability. To overcome the negative impact, IoT developers must be worried about the environment. The environmental impact of IoT devices is one of the challenges. Internet-enabled services and cutting-edge equipment are rapidly increasing energy usage. This topic requires research to provide high quality materials for new IoT devices that consume less energy. Green technology can also be used to produce future energy efficient equipment. It benefits both the environment and human health. Researchers and engineers are working on extremely efficient IoT devices to monitor diabetes, obesity, and depression. Several studies explore environmental, energy, and healthcare issues.

Smart city, transport and vehicles

We are moving from traditional civil structures to high-tech ones with IoT. Supporting technologies like machine learning and natural language processing are helping to better understand the necessity and use of technology at home. Technologies like cloud servers and wireless sensor networks must be utilized with IoT servers to create a smart city. A smart city's environmental impact is also vital to consider. So, when designing and building smart city infrastructure, energy efficient and green technology should be considered. Furthermore, smart devices in new vehicles can detect traffic jams and recommend an alternate route to the driver. This can help reduce traffic in the city. Also, low-cost smart gadgets should be built into all vehicles to monitor engine operation. IoT also fails to maintain vehicle health. Intelligent sensors allow self-driving automobiles to communicate with one other. This would improve traffic flow compared to human-driven autos that used to stop and go. It will take time to implement this technique globally. Until then, IoT devices can detect traffic congestion and take appropriate action. To benefit society, a transport manufacturing company should embed IoT devices into its manufactured cars.

Agriculture and industry automation

The world's population is expected to double by 2050. Agriculture is vital in our life. To feed such a large population, we must improve current agricultural practices. Thus, agriculture and technology must be combined to increase production efficiency. Greenhouse technology is one possible solution. It allows controlling environmental conditions to improve output. Automation reduces efficiency, increases costs, and reduces production when done manually. IoT smart devices and sensors make it easier to operate and monitor the process, resulting in energy savings and improved productivity (Pasupuleti, 2015b). Industry automation is another IoT benefit. IoT has revolutionized factory digitalization, inventory management, quality control, logistics, and supply chain management.

CONCLUSIONS

Recent breakthroughs in the Internet of Things have piqued the interest of researchers and developers all over the world. The Internet of Things (IoT) developers and academics are collaborating to expand the technology on a broad scale and to benefit society to the greatest extent possible. However, improvements are only achievable if we take into account the many challenges and weaknesses that now exist in the technical approaches. In this survey post, we discussed a number of difficulties and challenges that IoT developers must consider while developing a better model for the Internet of Things. In addition, significant IoT application areas are highlighted, including those in which IoT developers and researchers are actively involved. Because the Internet of Things (IoT) not only provides services, but it also generates a massive amount of data. As a result, the significance of big data analytics is also explored, which can offer accurate decisions that can be used to construct a better Internet of Things system is discussed.

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