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Internet of Things Impact on Web Technology and Enterprise Systems

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Abstract

It's been clearer over the last two decades that computer science plays a crucial role in the growth of every company. With each passing cycle, the IT industry blossoms a brand-new subfield. The Internet of Things (IoT) refers to the idea of connecting any device to the Internet in order to interact with the consumer and convert it into an intelligent device; this is a relatively new concept in the realm of information technology (IT) and the Internet, but it is gaining popularity and importance in people's daily lives. The Internet of Things is predicted to play a pivotal role in the development of business IT infrastructure. With the help of IoT, we can link billions of smart gadgets that can talk to one another in an automated fashion. One of the most rapidly expanding fields in computer history, with an expected 50 billion devices by the end of 2020. Security techniques, such as encryption, authentication, access control, network security, and application security, are rendered useless when applied to Internet of Things (IoT) devices because of these inherent weaknesses. The Internet of Things (IoT) has attracted the attention of many academics and industry leaders, who have published studies and made statements on the significance of IoT architectural layers for corporate systems (ESs). This literature study included a wide variety of studies that implemented and developed IoT technology in several human domains, including healthcare, smart homes and cities, assisted charities, and monitoring systems. The article also detailed the computers and programs that facilitated each study. Plus, the reliable algorithm used in the research articles' tests and analyses of data. Lastly, drawing parallels between these publications helps to provide insight on the difficulties and possibilities facing potential IoT impact researchers in the industrial sector.

Keywords: *IoT, E-IoT, Technologies of IoT, Service-Oriented Architecture for IoT, Evolution of ESs*

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I. INTRODUCTION

The Internet of Things (IoT) is an exciting new phenomenon that has the potential to dramatically alter our day-to-day lives [1]–[5]. This potential extends from the Internet of Things' capacity to facilitate sustainability to projects such as Green IoT. Emerging technology such as the Internet of Things has the potential to have a large influence on a number of preexisting industrial institutions, including those engaged in transportation and manufacturing [6]–[8]. The Internet sof Things enables transportation authorities to monitor and regulate the movement of individual cars in real time, as well as predict where those vehicles will be and how they will effect traffic flow. The basic idea behind the Internet of Devices was sparked by the concept of interconnected things that are able to speak with one another. The word for things that can communicate with one another and are outfitted with RFID [9]–[11].

The Internet of Things, often known as IoT, is a subject that has people all over the world experiencing a mixture of excitement and terror due to the rapid pace at which it is developing. The emergence of new technologies has been the driving force behind every significant change in the manufacturing paradigm [12]–[14]. The development of computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided assembly (CAx), as well as the widespread usage of CNC and industrial robots, prepared the way for the establishment of flexible manufacturing systems (FMSs) and computer-integrated manufacturing (CIM) (CAPP). As ESs continue to expand, an increasing number of businesses are turning to the knowledge and experience of specialists in the field of information technology software service to either complement or replace their old legacy systems [15]–[18].

Energy-Saving and Emission-Reduction (ESER) refer to conserving material and energy capital while also reducing waste and environmentally hazardous materials emissions [19]–

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[22]. The assessment based on the assessing goal determines the implementation principles for limiting GHG emissions. Accurate GHG emissions estimation is a requirement for its implementation. All index data is untrustworthy without a precise quantitative examination. ESER includes reducing GHG emissions [23], [24]. The importance of the ESER assessment for achieving ESER's goal can be seen from the analysis of reducing GHG emissions. A complete ESER evaluation guidance is needed for a thorough implementation of ESER evaluation [25], [26]. QoS limitations and SLA are two issues that arise when allocating IoT resources. The QoS must be guaranteed by the IoT method. A Service Level Agreement (SLA) is a contract between a service provider and a customer that specifies the Quality of Service (QoS) [27]–[29].

As a worldwide information network that prepares the path for business that transcends national borders, the Internet of Things (IoT) is gaining momentum and gaining popularity. The International Telecommunications Union (ITU) stresses improvements in item identification, sensor technology, and the capability for environmental communication in its description of the Internet of Things (IoT) [30], [31]. Since the introduction of cutting-edge consumer electronics, more than 45 million intelligent home components have been marketed in different regions around the world [32]–[34]. The installation of commodity systems, which are often referred to as innovative off-the-shelf systems, may be carried out by the typical end-user with little to no special preparation required (e.g., Samsung SmartThings, Google Home) [34]–[37]. The term "Future Internet" refers to a collection of up-and-coming technologies for the transmission of data via networks. The Internet of Things (IoT), which stands for the Internet of Things, is now the most well-known and significant concept of the Future Internet. It acts as a platform for connecting networked items and seamless networks, which is the norm for information technology all over the globe. On the future Internet, users will be able to contact and engage with any entity, no matter where they are located in the globe, by making use of any service or network that is now accessible [37]–[39].

The Internet of Things makes use of the Internet as a global networking environment for a broad range of physical things, which enables it to promote the wireless transmission of data and interaction between those physical devices. The information and data we have are very important to our day-to-day existence [40], [41]. There is a pervasive information-driven perspective on today's corporate systems, as seen by the proliferation of IoT and service-oriented enterprise structures, social networks, smart portable devices, and intelligent automobiles. This can be seen as a result of the rise of the Internet of Things (IoT) [42]–[44].

A new era has started with the introduction of the Internet of Things (IoT), in which the innovation of business processes is being driven by a network of computers and other devices that are capable of connecting and interacting with one another [45], [46]. When the number of people using the Internet and their ability to access it rose twenty years ago, businesspeople recognized an opportunity to build new sorts of companies that might flourish in the digital sphere. Because of the widespread availability of internet connection, cyber system implementations, and structural sensor systems, next-generation corporate systems have been created since then [47]–[49]. The Internet of Things (IoT) provides a variety of resources that are essential to the functioning of communication channels and network infrastructures. Some examples of these resources are load balancing, traffic analysis, and channel capacity. Create a classification system for the resource distribution . Improving collaboration between IoT resource allocation and business architecture is one of our primary goals [50]–[52].

The remaining sections of the article are organized as shown below: In the next section, we will talk about the Internet of Things as it relates to the business sector. The evolution of the ESS is discussed in part 3. In this section, we will go over the IoT technology in great detail. In the fifth part, the service-oriented architecture of the Internet of Things is broken down in further depth. The Literature Review is located in section 7, so make sure you look there. In this last section, we will be drawing parallels between the many research that we have already reviewed and analyzed. The conclusion to be drawn from this endeavor is presented in part 9.

II. WEB TECHNOLOGY CONCEPTS AND WEBSERVER LOAD BALANCING

The term "Web Technology" refers to a collection of terms that together refer to technologies that are based on the internet and are used to exchange data between computers and other devices. Users of the Internet are required to utilize a web browser in order to see websites [53]. Users are able to see material from the World Wide Web using software known as browsers. This content includes text, data, images, animation, and video. Users are able to traverse the World Wide Web and the various resources that are linked with it via the use of software tools known as web browsers. The following are some of the several classifications that may be used to web technology:

The World Wide Web, abbreviated as "WWW" The World Wide Web is supported by three primary technologies: the Hypertext Transfer Protocol (HTTP), the Hypertext Markup Language (HTML), and web browsers (HTTP). A web browser is a piece of software that allows users to navigate and see content on the World Wide Web (World Wide Web) [54], [55]. It makes it easier for the client to communicate with the server and makes it easier for the server to fulfill the demands of the client for web-based information and services. A web server is a computer program that saves and distributes web page files in response to requests made by clients across a network. These requests come from the client computers. For the purpose of this communication, HTML Transfer Protocol is being used (HTTP) [56].

Web pages are a kind of digital document that may be seen by anybody who has access to the internet as well as a web browser. The process of planning, creating, and maintaining websites is referred to as "web development," and includes all three of those steps. The term "web development" refers to a broad field that includes a variety of subfields, such as database administration and graphic design [45]. The process of establishing a website or any other form of program that runs on the internet is referred to as web development. There are two primary categories that may be found within the realm of web development: The Process of Developing the Front End: When discussing websites, the area with which the user interacts directly is referred to as the "front end," and this is the meaning of the term "front end." This component of the software is also known by its alternative name, the client interface [57].

Coding done on the server side of a website is referred to as "backend development." It's the part of the website where users can't see anything or interact with it in any way. It is the component of the application that the end user will never see or have any interaction with. It is used for the purpose of filing and organizing information. Load balancing is a technique that must be used in order to distribute the workload of a website or application evenly among many servers (sometimes called nodes). Numerous protocols are employed in order to intelligently split up traffic over multiple servers so that it may be directed to a single IP address. Therefore, the performance of your website or application is increased during high times of traffic thanks to the distribution of the processing weight across numerous nodes rather than just one. It is possible to construct a load balancer in either a physical or a virtual form. In web hosting, load balancing is a technique that distributes HTTP requests sent to a website over many servers so that the website seems to have a single front end address [58]. When a person visits a website or logs into an application, the content that they view is known as the web front-end. In addition, load balancing makes it possible for you to construct a website or online application that has a high level of availability. In the event that one of your servers goes out, the workload will be distributed uniformly among the remaining nodes. Server load balancing, often known as SLB, is a method that splits the burden of high-traffic websites over a large number of servers. SLB is an acronym for "server load balancing." This is often performed with the assistance of a hardware- or software-defined device that is based on a network. Additionally, the process of traffic being intelligently dispersed across a number of various geographical sites is referred to as "global server load balancing," which is a word that refers to the process (GSLB) [59].

The technique of equitably dispersing the work load of a high-traffic website among a number of servers is referred to as server load balancing, abbreviated as SLB. SLB may be performed by the use of a hardware- or software-defined device that is based on a network. In addition, the practice of intelligently distributing traffic over a large number of geographical sites is referred to as "global server load balancing," which is another word for the procedure (GSLB). It is feasible for the servers to be hosted either on-premises in the data centers of the organization or in either a private cloud or the public cloud. Both of these options are available. Either of these choices is an option. The load balancers for the servers are responsible for distributing the requests that users of the website make to the appropriate servers [60].

These days, the vast majority of load balancing for servers is accomplished via the use of one of the following two basic methods: Load balancing is achieved at the transport level via the use of a DNS-based strategy that functions invisibly and transparently inside the application data. The load balancing functionality that is included in Windows servers is an example of application-level load balancing. This kind of load balancing makes its balancing choices based on the volume of traffic that is entering the system [45][46].

When incoming network traffic is distributed over several servers using web server load balancers, application delivery to end users is better, and end users have a more consistent experience utilizing the applications they use. IT departments are starting to understand the relevance of load balancers for servers as a consequence of the many advantages that load balancers provide, which are as follows: The scalability of load balancers comes from their ability to adjust the amount of resources that are allocated to a pool of servers so that it can best manage peaks in application use while still guaranteeing the application's highest possible level of performance. Redundancy is the process of protecting a system against the failure of both its hardware and its software by installing several web servers to supply identical copies of the same information [61]. This is done in order to reduce the likelihood of the system becoming inoperable. If there are server load balancers in place, the traffic for any servers that have a failure may be promptly redirected to other servers that are operating normally. Having a focus on providing service while also working efficiently: Businesses that have web servers located in many locations and numerous cloud environments can perform maintenance at any time to boost performance without negatively impacting application uptime if they use server load balancers to reroute traffic to resources that are not undergoing maintenance. Server load balancers reroute traffic to resources that are not undergoing maintenance. This is feasible due to the fact that maintenance may be carried out at a number of different areas all at once [2], [5].

For HTTP interactions, a straightforward request-and-response style is used. This format is also utilized for load balancing purposes for HTTP servers. On the other hand, a TCP load balancer will not be able to properly balance traffic for an application that exclusively uses HTTP. Either the layer 4 or the layer 7 protocol may be used to do load balancing for the TCP protocol. It is feasible to carry out additional operations with HTTPS traffic if a reverse proxy, which is what an HTTP load balancer is, is used. This will allow for greater security [54], [62].

Avi Networks provides its corporate clients with cutting-edge load balancing for multi-cloud environments, both in the data center and on the clouds themselves. This load balancing solution has a new method for handling both local and global server load balancing, and it is one of the solution's strengths. You will have the chance to distribute traffic across both live and backup data centers with the assistance of this feature [63]. The coordinated exchange of network activity between two data centers that are both being used at the same time. The storage of information and the presenting of that information according to geographic coordinates. uniformity across each and every one of the different data centers. The user has access to a variety of data and analytical choices, and these options are available for each and every transaction [58].

The servers that are situated in a company's data center are put under a larger level of pressure if there is more traffic inside the company's network or on the company's website. An increase in the number of requests made to access the applications and data stored on a server results in an expansion of the server's capacity to perform those requests. The steadily growing number of users logging into the service creates a snowball effect that, in the long run, causes it to become unstable. Businesses have a higher chance of avoiding a server overload, which might lead to a shutdown of the data center, if they use a rapid server load balancer. This is because the load balancer distributes the server's workload more evenly [64].

The ability of servers to absorb an increase in traffic without suffering a drop in performance or becoming inaccessible to users is a key benefit of load balancing. Throughput and application response times have the potential to be enhanced if network and web traffic is distributed over a large number of servers. Data centers that use server load balancing solutions typically employ the use of a multi-layer switch for the purpose of evenly distributing network traffic without negatively impacting the performance of application delivery. This is accomplished by distributing network traffic across multiple layers [65].

Customers may be routed to either internal or external networks in the information technology designs of a vast number of businesses. These designs often consist of a large number of network channels. When many servers work together to carry the load, customers never again face the possibility of experiencing connection problems, slowed data retrieval, or delays in service. It is the responsibility of server load balancing to ensure that clients have uninterrupted access to the data that is kept on the servers. Server load balancing accomplishes this goal by keeping several paths to data stores accessible in response to distributed server requests. In the event that a server goes down, this backup strategy will be activated to take its place as the primary path and perform its functions. Maintaining top performance requires a robust infrastructure, which can be attained by ensuring that business applications are always accessible through internal networks. Another option for achieving this goal is to invest in new hardware [66].

A strategy known as load balancing may be used to distribute the additional HTTP traffic that a website gets to the web servers that are best suited to handle it. The technique of dividing the excessive traffic that is sent at a website among a number of servers is known as web server load balancing. A multi-layer switch is used in order to achieve this goal successfully. Each and every HTTP request that is sent to the website of an organization and is received is then sent by the switch to the proper server that is situated inside of the data center. Load balancing is a strategy that may be used to evenly distribute increases in internet traffic. This, in turn, helps to reduce server congestion and enhances the performance of websites [67].

Radware is a provider of solutions for server load balancing, which are used for the purpose of controlling the traffic in data centers. These technologies make it possible for businesses to get the most out of the servers they already have, increase the speed of their networks, and prevent disruptions that may cost them money.

Because we provide a powerful application delivery controller known as AppDirector, your firm may now link its apps to its network. This capability was previously unavailable to your business. Because it supports a wide variety of application delivery protocols, AppDirector makes it possible to improve performance while simultaneously lowering the amount of downtime experienced by the system. Server load balancing is one of these services that may be used [68].

III. ENTERPRISE INTERNET OF THINGS (E-IOT)

The deployment of a functional E-IoT system is broken down into specific steps by the E-IoT solution. Figure 1 presents a diagrammatic representation of an E-IoT system. Conventional consumer Internet of Things (IoT) systems may be differentiated from electronically-enabled Internet of Things (E-IoT) systems by the particular design and deployment techniques of the latter. The components that make up the E-IoT system may be broken down into these four categories: the actual devices, the controller, the user interfaces, and the drivers.

Because every installation is different, there is no one way to implement an E-IoT system that is universally accepted. E-IoT systems are built on a foundation of hardware devices, which may include anything from sensors to computers or even other devices. These devices serve as the basis (e.g., sensors, televisions, lighting modules). E-IoT systems need drivers in order to include physical devices since they offer the system with all of the information that it requires in order to incorporate the item correctly. Data such as the model number, protocol, code, instructions, and hardware interfaces are all included inside the drivers. It is important to add a driver for each individual device [69].

The controller is the "brains" of an Internet of Things (IoT) system since it is where all of the essential drivers and user-tailored code are located (e.g., scheduled events). Last but not least, user interfaces are the key way in which end users interact with the infrastructure of the E-IoT. After third-party devices have been integrated, the end user may utilize user interfaces such as tablets, phones, and remote controllers to operate and manage integrated equipment. A user of the Internet of Things may use an application on their smartphone as the interface in order to perform actions as elementary as turning on a light.

The controller then activates the light by using the inbuilt intelligent light driver that is included inside the E-IoT lamp. Hardware, networking, drivers, proprietary software, and wireless technologies are only some of the various components that are required to carry out an E-IoT operation [70]. E-Internet-of-Things systems are capable of performing a wide range of tasks, as specified by their respective specifications. One of these goals is specialization; for instance, both companies and yachts may reap the benefits of centralized lighting control systems [71].

E-IoT solutions also bring together separate components of an intelligent system (such as Savant, Crestron, or Control4) so that those components may operate and interact with one another as if they had always been a part of the same system. The integrator receives all of the training and tools required to successfully complete the configuration process from the vendor of the system. Hardware and software for the E-IoT (including integrated devices and drivers, for example) may have been sourced from providers or sources that are unknown or not trustworthy [72].

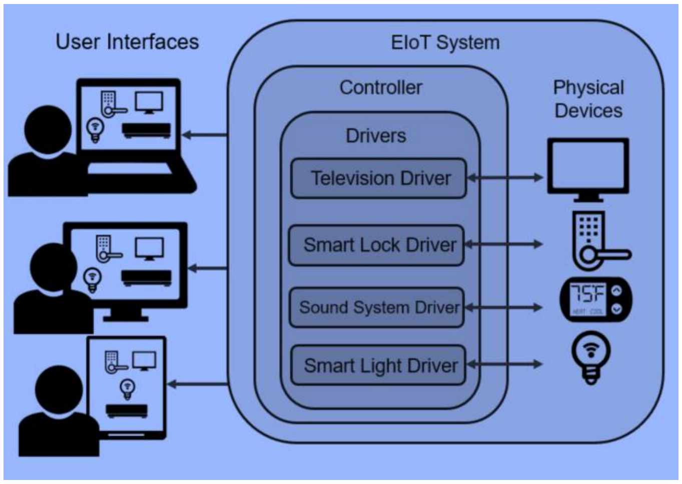

Fig.1. A typical E-IoT solution architecture with user interfaces, controller, and physical devices [35].

IV. EVOLUTION OF ESS

A manufacturing system manufactures value-added goods using various manufacturing facilities such as machines, equipment, and workforce. For all stages and realms of manufacturing processes, the architecture and execution of a manufacturing system entail various decision-making types. Enterprise architecture is a term that refers to the elements of a structure and its relationships [73]. In any system or subsystem, a decision-making process may be interpreted as a sequence of design activities:

1- defining the essence, boundaries, and objective of a design competition. 2-establishing relationships between inputs, outputs, and system parameters through the use of relational models. 3-collecting and managing data about the present state of the scheme. 4-make design-related choices. The enterprise's ES is in charge of data acquisition and maintenance and acting as a decision-making tool. Consequently, it is possible to analyze the characteristics of an ES through the prism of decision-making processes [74].

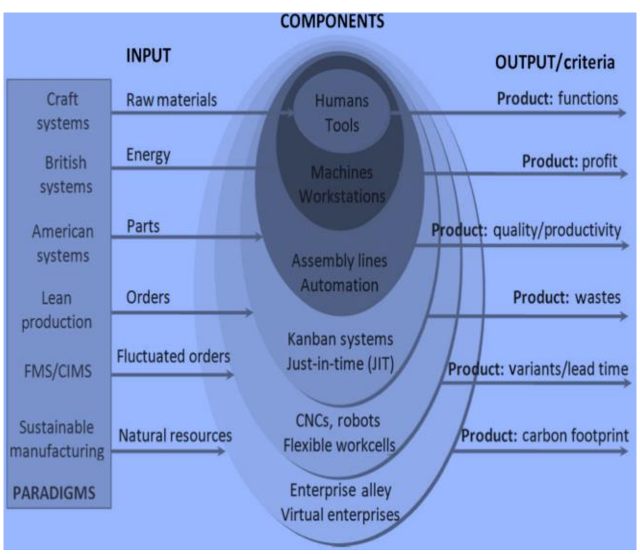

Fig. 2. Evolution of inputs, outputs, and system components [74].

V. TECHNOLOGIES OF IOT

Through the usage of the internet, virtual embedded devices that are equipped with sensing, processing, and networking capabilities may be able to pool their resources and collaborate with one another to offer improved service to their customers [75]. The technologies that are used in the process of allocating IoT resources are shown in a schematic format in Figure 3.

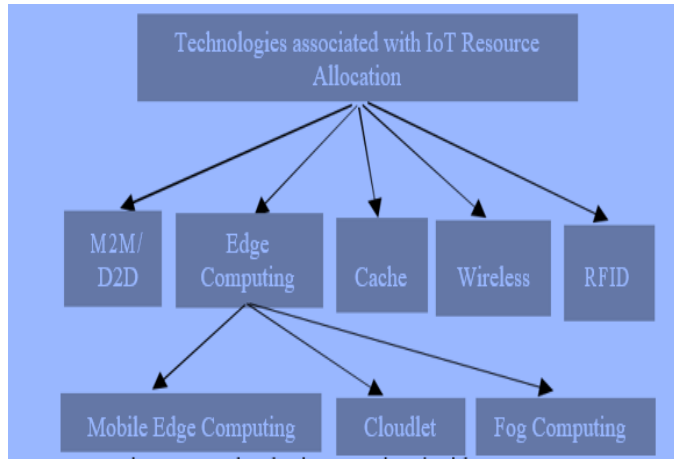

Fig.3. Resource Allocation Technologies for the Internet of things [75]

The Internet of Things has a number of different standards, some of which include radio frequency identification tags, switches, actuators, and mobile phones. The processing and storage of data are moved closer to the location at where they are generated by edge computing. Even though it's still in its infancy, computing in the fog is becoming more popular. In recent years, there has been a meteoric rise in the number of people using smartphones and other types of smart consumer technology. These self-driving personal devices are in a league of their own when it comes to the processing and networking capabilities of their components. They are helpful for producing fleeting mists that have a fluffy appearance. On the other hand, tiny cell base stations and home hotspots that are powered by Wi-Fi are becoming increasingly widespread. In addition to the establishment of microcellular base stations and residential hotspots, specific fogs may also be molded using dedicated computing facilities, which may be set up in conjunction with [76].

A. Fog-Computing

The edge of a network is where low-latency computing services provided by fog computing are located. In order to effectively serve time-sensitive Internet of Things applications, fog-enabled network architecture and services may make efficient use of resources that are relevant to specific regions. The total network throughput efficiency and quality of service for end users is improved when backhaul traffic transfers are decreased, and unified processing requirements are met (QoE). "Fog computing" or "clouds at the edge" are two names for a new kind of computer technology that positions resources close to endpoints to enhance the quality of service [77].

An example of an Internet of Things ecosystem may be seen in, which depicts a computer hierarchy at the top and a community of Internet of Things users below it. In this configuration, fog computing eliminates backbone traffic to the cloud while also increasing application latency for time-sensitive Internet of Things tasks. We are able to greatly reduce the amount of time necessary to carry out remote cloud computing if we move the processing to fog nodes that are located locally. In this configuration, the processing capacity is provided collaboratively by fog nodes and far-flung cloud servers working together. Users of the Internet of Things who are located nearby have the potential to profit from the computing resources provided by fog nodes [78].

B. Mobile Edge Computing

In recent years, there has been a meteoric rise in the number of people using mobile devices. It may be challenging for intelligent mobile devices to execute mobile applications due to the restricted processing power and battery life of these devices (SMDs). As an example, the central processing unit (CPU) of a smart mobile device has a low frequency as well as memory (CPU). Because it brings cloud computing capabilities closer to smart mobile devices, mobile edge computing (MEC) is being standardized as a novel architecture and essential technology by an Industry Specification Group of the European Telecommunications Standards Institute (ETSI). This is because MEC delivers cloud computing capabilities more quickly. Offloading calculations performed by MEC provide a number of advantages, two of which are decreased latency and improved service quality (QoS). All incoming data is processed by the MEC's servers, which are located close to end users and deep inside the radio access infrastructures of cellular networks [79].

C. Wireless

As a consequence of this, the incorporation of wireless technology is essential for the Internet of Things. It has been said that the Internet of Things (IoT) and cellular networks are incapable of functioning without the global reach, resource management, guaranteed and stable resources, mobility and roaming support, and other capabilities that are only achievable with licensed wireless technologies [80].

In recent years, wireless sensor networks, often known as WSNs, have emerged as a promising technology with a wide range of possible applications. WSNs rely on a large number of relatively tiny nodes known as sensor nodes, each of which is outfitted with sensing, data processing, and networking equipment. These nodes are responsible for performing sensing duties. In recent years, there has been a meteoric rise in the quantity of data that is transmitted and received via mobile devices. In order to make room for intelligent environments, industry 4.0, and other cutting-edge technologies, 5G networks and protocols are currently being developed to address issues that are present in existing mobile wireless networks. These issues include enhanced availability and computing infrastructure capacity. As the use of wireless networks becomes increasingly widespread, problems such as latency, quality of service, and the installation of IoT devices appear [81].

D. Device-To-Device Communication

Due to the fact that D2D communications make it possible for devices to connect directly with one another without the assistance of a local base station (BS), this kind of communication has attracted a lot of interest in the realm of cellular networks. Efficiency is improved in a variety of ways thanks to the use of D2D. As a result of the short-range connections, proximal D2D systems may have advantageous characteristics such as high data transfer rates, low end-to-end latency, and low energy consumption. Direct communication between devices is preferable to going via a sophisticated base station (BS) and maybe a core network since it is both more efficient and requires less resources. Direct communication also eliminates the need for a middleman. In addition, direct-to-device (D2D) connections contribute to the reduction of congestion in the cellular network by unloading bandwidth from normal users. To be more specific, it increases the spectrum performance of cellular communication networks as well as the effectiveness of edge user communication [82].

E. Machine-To-Machine Communication (Machine Type Communication)

Through the use of M2M technology, electronic devices such as phones, computers, lights, refrigerators, and other sensors are able to communicate with one another without the need for human intervention. Low-power transmitters, such as Bluetooth or RFID, are used to report and send sensing data, which may include data on temperature, acceleration, and other factors. It is possible to collect data from linked devices, transmit that data to a remote server, analyze that data, and exercise control over the connected devices with the assistance of an M2M gateway. The on/off state of the light may be controlled by a cloud server, for example in order to conserve electricity or so that a user who is away from home can check in on what their property looks like via a security camera. [Clarification needed] The requirements for bandwidth and latency for M2M networks are quite variable [83].

VI. SERVICE-ORIENTED ARCHITECTURE FOR IOT

The Internet of Things (IoT) intends to link every conceivable kind of electronic device by using networks. The Internet of Things (IoT) might potentially gain advantages from service-oriented architecture (SOA), which is an essential method for combining different kinds of systems or devices. Cloud computing, wireless sensor networks, and vehicle networks are only a few examples of the research fields in which SOA has shown to be a useful tool. There have been several suggestions made for multi-layer SOA architectures for the Internet of Things (IoT), and these suggestions differ according to the technology that is being utilized, the business goals, and the technical standards. According to a proposal made by the International Telecommunication Union, the architecture of the Internet of Things (IoT) may be split down into five separate levels. These levels include sensing, accessing, networking, middleware, and application (ITU) [84].

It is discussed in this article [85] various aspects of the architectural design of the Internet of Things, such as architecture types, networking and communication, intelligent devices, web services and apps, business models and the accompanying procedures, cooperative data processing, and security.

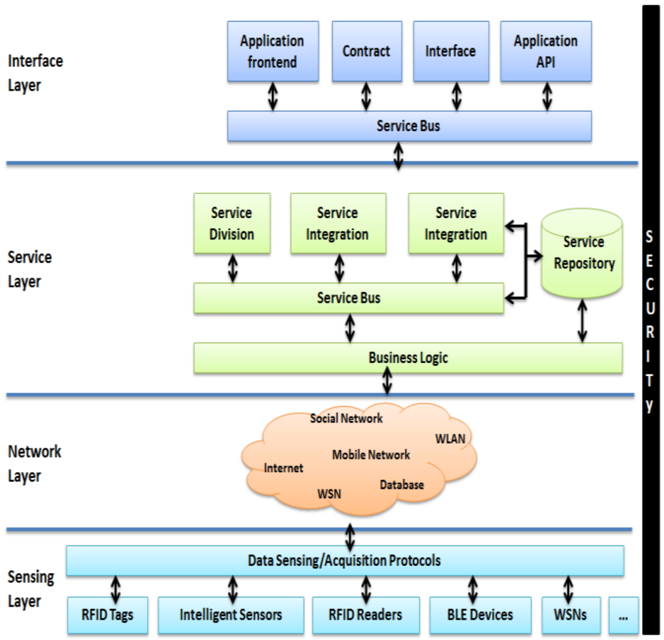

Fig.4. Service-oriented architecture for IoT [85]

A. Sensing layer

The Internet of Things (IoT) refers to a global network of linked physical objects that may be controlled and monitored from a distance. It is made a great deal easier to link things when more systems employ radio-frequency identification (RFID) or intelligent sensors [86]. Tags or sensors may be able to autonomously identify and interact with other devices in the sensing layer of intelligent wireless networks. Because of these advancements, the Internet of Things is now far better equipped to detect and recognize objects in the physical world. Every service or system that is necessary for a certain industry is assigned a universally unique identifier (UUID), and then it is distributed making use of an intelligent deployment strategy. Computers that are clearly recognizable and have identifying numbers that are globally unique have a better chance of being retrieved (UUID). Because of this, Unique Identifiers for Things (UUIDs) are very necessary for the efficient deployment of networks inside a huge network like the Internet of Things [87].

B. Networking layer

The networking layer's job is to create connections between the nodes in the system and to make it easier for them to share information with one another. Because of the networking layer, it is possible to compile information from different IT systems already in place, which is an extra advantage (e.g. business systems, transportation systems, power grids, healthcare systems, ICT systems, etc.). In SOA-IoT, heterogeneous network deployment is often used, and all connected devices are made accessible over the service Internet [88]. This technique makes it feasible to implement methods for monitoring and managing the quality of service in accordance with the requirements of the user and the application. When it comes to dynamic networks, on the other hand, the capability to automatically find and map sections of the network is absolutely necessary.

C. Service layer

The development of the service layer makes use of middleware technologies in order to make it easier to integrate applications and services related to the internet of things. Middleware design makes it feasible to reuse both hardware and software platforms, which paves the way for the creation of a low-cost interface for the Internet of Things (IoT). There is a possibility that organizations may depend on the service layer to create their middleware service requirements. A well built service layer should include the fundamental configuration specifications, as well as the application programming interfaces (APIs), as well as the protocols necessary to deal with services, applications, and user requirements. The administration of knowledge, the storage of data, indexing, searching, and communication are all examples of service-oriented subjects that are included in the scope of this layer. This layer could include the following elements at some point: The process of locating objects that can give data and resources in an effective manner is referred to as service discovery [89].

D. Interface layer

Despite the fact that there are many different Internet of Things devices on the market today, not all of them conform to the same standards or protocols. The wide range of products that make up our daily lives presents a host of interaction issues, not the least of which are the need to share information, communicate with one another, and work together to interpret events. In addition, as the number of devices that make up an Internet of Things increases, it becomes more challenging to dynamically connect, communicate, detach, and function. The administration of objects and their connections need, in addition, the existence of an interface layer. Applications are given the ability to connect with a network thanks to the IFP, which is a subset of service standards. This was made feasible with the development of a protocol known as UPnP, which describes how different devices may connect with one another in order to make advantage of the services provided by the other device. The profile that should be used for an interface may be determined using [90].

VII. LITERATURE REVIEW

According on the findings of D. D. Koo and colleagues [91], in this thesis, we suggest an architecture for the Internet of Things (IoT) and endeavor to develop a huge data model. This article presents a comprehensive conceptual strategy for creating and implementing an Internet of Things infrastructure for the purpose of enhancing restroom safety. The writers explore the following four concepts throughout this work: The first four phases are to establish a wireless sensor local network architecture, a design concept for deploying the Internet of Things, a paradigm for processing huge volumes of data, and to gather and install sensors. In the thesis, both a pilot test technique and an overarching data structure are put up as potential solutions. In order to manage such enormous volumes of data, a variety of computer programs and open-source platforms will be tested and assessed. The huge potential of big data and the Internet of Things to promote consumer sustainability in a number of ways is clearly shown here.

According to the findings of M. Abdel-Basset and colleagues [92], this study proposes a novel approach to the management of supply chains that makes use of the Internet of Things (IoT) technology. Because of the proposed system's automatic product identification, worldwide shipping tracking, accountability, cost savings, and time reductions, the end result will be a client base that is better happy with the service they received. The newly established website by the management simplifies communication and gives suppliers fast access to sale information by requiring just a login and a password from them. Our platform enhances the results for all parties involved by cutting away the middlemen and making it easier for management and suppliers to communicate with one another directly.

Pal [93] present an architecture for Internet of Things (IoT) applications that is based on distributed data management. This architecture makes it feasible to execute transaction services and uses the case of a multi-party garment supply chain as an illustration. The authors describe a hybrid business information management architecture that is based on software for the Internet of Things and a distributed ledger that is based on blockchain technology. The goal of this architecture is to improve transaction services within a multi-party global garment market network. The Internet of Things (IoT) is a global network of intelligent, linked things that are capable of exchanging data with one another and coordinating with outside parties to achieve common goals utilizing preset addressing protocols. The incorporation of Internet of Things applications into the operations of a clothing company may significantly accelerate the time at which business decisions are made owing to the data offered by these applications. Isolated IoT application platforms, on the other hand, make security and privacy concerns far more difficult to manage.

Sutari [94] explain the components that make up the framework of IoT-enabled business networks. These components are what make up the framework. A case study of a real-world installation of a fundamental home security system is presented in the following sections. The system was built on top of a secured Linux server, which guarded the credentials of all of the linked workstations and ensured their security. In addition, the procedure of storing data on a server for the purpose of safekeeping and then accessing that data at a later time for the purpose of seeing or analyzing it was shown. We spoke about the procedures and hardware involved in putting up a solid server.

Deng [95] discovered that the home Internet of Things is plagued by a variety of challenges, some of which include the production of electrical appliances, consumer usage, operation and maintenance, and security regulation. These are just a few examples of the many challenges that exist. As a result of this, the purpose of this paper is to propose The Embedded Modules Solution of the Household Internet of Things System. This is an Internet of Things system for the house that enables the management of all electric appliances using a single smartphone terminal. Extending, integrating, and further refining this system are all potential avenues for making improvements. In addition, this article provides an overview of the evolution of the Internet of Things (IoT), breaking it down into three distinct phases: "Internet of things with electrical equipment," "Internet of things with any device," and "Artificial Intelligence Internet of things."

IoT-based context-aware architecture that can capture intricate real-time requests from suppliers and consumers and conduct real-time matching based on collected data has been presented, as stated by V. S. A. A. A. Don et al [96]. In this section, we will talk about the thought process that went into suggesting the reference architecture that we did, and we will also present the concept of smart food sharing containers. An innovative container that is rigged with sensors serves as the experimental prototype for the verification of the practicability of a given theoretical solution.

We appreciate A. Saxena and his colleagues' [97] participation in this conversation and thank them for their contributions. Students are having difficulty grasping key concepts in the new environment, which is leading to a progressive decline in the standard and quality of engineering education. As a result of this, the standard and quality of engineering education is steadily decreasing. It's possible that students' inability to grasp the material being covered in class is to blame for the overall quality of education continuing to deteriorate. The findings of the research provide a potential solution to the problem. It takes into consideration people's preferences about how they learn best, whether it be visually, aurally, or kinesthetically, and is predicated on the premise that everyone is unique in this regard (VAK Theory). As a result, the approach that was presented places an emphasis on categorizing pupils into groups according to the ways in which they like to learn. The proposed system takes use of the Internet of Things in order to automatically identify students, record their grades, assignments, and submission history, among other things. Additionally, the system customizes assignments to correspond with a student's preferred method of being instructed. It is possible that the researcher will be able to improve student performance by as much as 42 percent by lowering the workload of teachers.

It has been suggested by D. Mishra and colleagues [98] that in order to improve water use and boost agricultural production, a terrain-specific, programmed water system should be utilized. This would eliminate the need for manual lab testing. A wireless LAN module, an Arduino starter kit, and a moisture sensor make up the components of this system. Our laboratory apparatus is linked to the internet so that it may communicate with the cloud and get data from there. After that step is completed, cloud services will analyze the data and provide helpful recommendations based on their findings.

The research conducted by A. Saxena and colleagues [99] provides a comprehensive account of the preparation and implementation of a low-cost, modular routing strategy. This approach makes use of hardware components such as the Raspberry Pi, NodeMCU, and MFRC552 Card Reader, in addition to software components such as Django, SQLite, and Python scripts. This study's focus is on analyzing how well the system is able to carry out its duties. This article described the design and execution of an alternative approach that is modular, wireless, and low-cost. The standard method was used as the comparison. Both the owners and potential hackers are prevented from accessing the system. The administrator is the only person authorized to make changes to the configuration of the server. A further reduction in the cost of the system is possible by the simple substitution of the Raspberry Pi with another SoC (System-on-Chip) device, such as the Orange-Pi [10]. In addition to that, security guards have a much less amount of work to accomplish. The system has the potential to be exploited for a variety of purposes, one of which is maintaining a record of student attendance in the classroom.

Post's precise instructions, which are based on the work of S. K. Vishwakarma et al. [100], make it possible for the light home automation controller unit to be readily installed. This is made possible with the aid of Post's instructions. With the help of the concept control unit, the common home appliance may be made brilliant and intelligent via the Internet of Things (IoT). We were able to successfully demonstrate the operation of the proposed model by physically connecting the three lights to one another. The approach that is being offered will, if implemented, have two advantages. To begin, the researcher may monitor our energy-efficient smart home from a distance using the Internet of Things (IoT) (IoT). One further advantage is that it is helpful to those who are disabled or old.

L. Nobrega and colleagues suggest employing technology connected to the Internet of Things to monitor the behavior of animals in their paper [101]. For autonomous sheep herding in vineyards, it consists of a local Internet of Things network for data collection from the animals and a cloud platform with processing and storing capabilities for the data collected. Specific information may be extracted from the data produced by the IoT network via the use of machine learning, which is made possible by the cloud platform. As a consequence of this, not only is the framework explained, but also a number of the platform's findings are broken down and spoken about. The capacity of this platform to detect and diagnose difficulties with animal postural health has shown promise in preliminary testing and reviews. This page presents a comparison of the many different algorithms that have been evaluated. Collars, mobile nodes carried by sheep, and a cloud network with tasks including data processing, storage, and analysis are all topics of discussion.

S. S. Siddula et al. [102] provide the groundwork for the development of a brand new information system by making use of already existing computer networks, various sensors, and the Internet of Things. This study also suggests an original method for capturing real-time water level data and sending it to an approved centralized command center through far-field communication. This method is proposed as a result of this research. A trustworthy central command facility is responsible for making the choice on whether or not to release the water by either opening or closing the dam gates. A direct result of this is the increasing centralization and automation of dam operations throughout the country.

Scholars F. Wu et al .[103] In this study, we provide an Internet of Things (IoT) network architecture that may be used for the deployment of networked health and safety applications in an industrial context that is outdoors. A network of wearable sensors that monitor workers' health and safety by recording physiological and environmental data and communicating that information to the device operator might be beneficial. Workers could profit from such a network. Discussion is had on the hardware and software architecture of sensor nodes, as well as the implementation of their gateways and clouds. As S. Ghazanfar et al. [104] presents IoT-Flock, an open-source traffic generating technology that is compatible with two IoT application layer protocols, the authors make a case for the use of the technology. The vast majority of open-source traffic generators are unable to successfully create attack traffic. On the other hand, IoT-Flock has the ability to produce malicious as well as benign IoT traffic, which may be put to use for testing and training IoT network defenses. Analyzing the traffic patterns of a real-time intelligent home use case is one of the ways that the IoT-Flock may be used to assist in the creation of an Internet of Things (IoT) security solution, as was explained. After that, the IoT-Flock platform was used to create the application for the smart house. The researcher then made use of IoT-Flock to build up an attack network that was specifically designed for IoT machines. After that, they gathered data traces of both healthy and infected network traffic.

According to S. Singh et al.'s [105] research, the effective management of traffic is an essential component of the administrative structure of any city. The combination of computer vision technology and the IoT approach helps in the creation of an artificially intelligent system that can efficiently manage traffic by estimating the number of vehicles that are expected to travel through a congested intersection. In the proposed framework, the only piece of hardware that has been used is a device based on Raspberry Pi. A simple and what would seem to be a cost-effective solution to the issue of traffic congestion at crossings during rush hours is shown here.

Authors R. K. Singhvi and others who contributed [106] You may be able to solve this problem by putting an Internet of Things-based device that notifies the company when the garbage can is overflowing and the degree of contamination. In addition to this, a website will be built in order to monitor data about trash cans. Not only does the GSM module update the website, but it also sends a message to the mobile device that is associated with the user. People may also use this website to report problems with trash cans and other aspects of waste management. An Arduino microcontroller is used in the proposed device in order to facilitate communication between the GSM/GPRS module and the sensors. An ultrasonic sensor was used to determine how full a wastebasket was, and a gas detector was used to evaluate the quantity of toxicity present in the air.

BP Tiwari, et al.[107], the issue of suffering from "Backache, Spinal Cord Bends, Muscle Strain, and so on" as a result of carrying heavy luggage on one's back is the focal point of this discussion. Using motion sensors, infrared sensors, and a GSM package, we were able to create luggage that could move independently only by detecting the leg movement of the owner, warning him or her of obstacles, and reporting the specific location in the case of a lost bag. In addition, we were able to create baggage that could move independently only by detecting the owner's leg movement. This enabled us to create baggage that could move independently (buzzer sound and notification on application developed for luggage). It is beneficial and easily accessible to individuals of all ages and stages, from very young children to senior citizens.

M. Khan and a group of other authors [108] The primary objective of the Digital Patient Eye project is to develop a patient monitoring device that is capable of processing and analyzing sensor data in order to determine whether or not a patient falls within a predetermined set of parameters. This device is to be low-cost, low-power, accurate, non-intrusive, and non-invasive. Another major objective of the project is to create an inexpensive patient monitoring device. When a patient's vitals hit a certain threshold, this device notifies the attending physician through the GSM module. In addition, the Serial Monitor that is located in the Outpatient Observation Department office of the supervising physician will display real-time data for each patient who is considered critical. In addition, the device was equipped with a buzzer that would sound if the patient moved beyond of his designated safe zone. The local medical staff is also made aware of the situation so that they may take whatever actions deemed essential to bring the patient back to normal as quickly as is practically practicable. The strategy has advantages since it lessens the workload placed on nurses to provide particular patient information to medical professionals. In addition, the decreased effort of the nursing staff will make it possible to streamline, simplify, and enhance the Hospital Management System.

S. Ding, et al., [109] the innovative attribute-based access control solution has significantly facilitated the simplification of the access management process for Internet of Things applications. The researcher makes use of blockchain technology to record attributes in order to protect the data from being manipulated in a central place or lost entirely. In addition, the method for regulating access has been tweaked to meet the requirements of IoT devices for high-efficiency and low-power computations. This was done in order to fit the network. Evaluations of our system's security and performance demonstrate that it is resistant to attacks and works well in IoT environments. Additionally, our system is efficient. The problem of cooking ingredient measurements is addressed by A.

Arya et al. [110] in a manner that is both novel and interesting. You may control it with an Android app or through an internet interface whenever and whenever you want to. Cutting-edge technology has enabled significant changes to be made to the layouts of kitchens and the ways in which items are presented. These changes include the addition of safety sensors for both chefs and guests. The Raspberry Pi serves as the controller for the sensors, which are then used to calculate the appropriate amounts of each component. The collection of data is only one of the numerous tasks that a software or website might take care of for its users. The inventory will be counted at a certain period, and then orders will be sent to the neighborhood merchants. There are heat sensors that, depending on the preferences of the user, may change the lighting in the room.

TABLE I. THE SUMMARY OF SEVERAL PAPERS

Ref.	*Year*	*Hardware*	*Software*	*Tools of accuracy Algorithms*	*Approach*	*Implemented Industry*	*Network usage*
D. D. Koo et al. **[91]**	2016	Arduino Positional Sensor Water Flow Sensor Energy Harvesting Sensor	Arduino IDE	FSR	Big Data Analysis	Healthcare	IFTTT With image technology and the cloud using Azure
M. Abdel Basset et al. **[92]**	2018	Esp8266 GIS, GPS sensors RFID	Website by HTML, CSS, JavaScript and PHP languages.	*N-DERMATOL With (AHP). analytic hierarchy process*	Information management system	Business model (BM)	Wi-fi with the Internet for GPS signals
K. Pal et al. **[93]**	2020	Radio Frequency Identification (RFID) readers with sensors	Service-oriented computing (SOC)	Chain network	Cryptography by blockchain	textile and clothing	Extranet, LAN, Internet
A. E. Systems et al. **[94]**	2019	CC3200 and ESP8266	Blynk server Java (TM) SE Run-time Environnent	Security server	Enterprise Systems	Home Security	Ethernet
Deng et al. **[95]**	2020	household IoT central Router	Cell-phone application	-	PLC Power-line Communication	Embedded System	Home- LAN by wi-fi
V. S. A. A. A. Don et al. **[96]**	2018	Raspberry Pi With weight and camera	Socket programming as client/server	Virtual Marketplace	Real-time Application	Aided Charity	GPS via Internet
A. Saxena et al. **[97]**	2019	Arduino Uno FPM10A fingerprinting module	Data-Base and Excel	auditory and kinesthetic (VAK Theory)	E-learning System	Faculty And Learning Organizations	Ethernet
D. Mishra et al. **[98]**	2018	Arduino kit Soil Moisture Sensor	Arduino IDE. (FPM10A fingerprint module) and Arduino board with necessary pin descriptions.	Humidity threshold value	Real-Time System	Irrigation	Wi-fi
A. Saxena et al. **[99]**	2018	Raspberry-Pi With RFID	Python's web framework Django	-	AI Recognition System	maintaining the records	Wi-fi
S. K. Vishwakarma et al. **[100]**	2019	NodeMcu (ESP8266)	IFTTT Web interface and Adafruit	voice recognition	Home Automation	Smart Home Controlling	Wi-fi
L. Nobrega et al. **[101]**	2018	Sensors with gateway	Message Oriented Middleware (RabbitMQ)	KNN and SVM	Machine Learning	Animal Grazing	Wide Band connected

S. S. Siddula et al. **[102]**	2018	Arduino Ultrasonic sensors Water sensors	Arduino IDE	Water threshold level	Water Level automation	Water Monitoring system	Lora WAN And Narrow Band IoT With Bluetooth
F. Wu et al. **[103]**	2019	MCU with BLE Function and Raspberry Pi Model 3	Digital Ocean Cloud Server	Real-time measurements from different sensors	E-Health	Healthcare monitor system	Lora WAN and Bluetooth
S. Ghazanfar et al. **[104]**	2019	MQTT and CoAP	XML	Random Forest RF	Network Security	Generate Attack traffic	WLAN
S. Singh et al. **[105]**	2019	Raspberry-Pi CCTV Camera	Open-CV with firebase	Frame Extraction	Image processing	Smart City Automated Car	Internet and GPS
R. K. Singhvi et al. **[106]**	2019	Arduino with SIM900A And MQ4 Gas Sensor	Website By HTML	Real-time measurements from different sensors	Automated dustbin	Smart City	GSM/ GPRS with wi-fi
B. P. Tiwari et al. **[107]**	2018	PIR and RF Transceiver TIVA C Microcontroller	mobile application	Real-Time	Automated luggage	Smart package Aeroplan	Bluetooth hc-o5 With GSM
M. Khan et al. **[108]**	2018	ATmega328 and LM35D IC	Arduino IDE	Serial Monitor	E-health Automated Hospital	Healthcare	GSM
S. Ding et al. **[109]**	2019	IoT different devices	Hyperledger Fabric On Ubuntu Linux	Practical Byzantine fault tolerance PBFT And (KGC)	Cryptography blockchain	Network security traffic detection	The network model composed of two entities, attribute authorities and IoT devices.
A. Arya et al. **[110]**	2019	Arduino UNO with Raspberry-Pi	Website and mobile application	E-payment	E-Commerce	Affordable kitchen	Internet and GSM

VIII. DISCUSSION AND COMPARISON

This section will demonstrate the base pros and cons of some papers displayed in the above table; in [103], the authors designed wearable devices based on IoT technology; they used Bluetooth and LoRWAN for communication for sending alarm and trigger messages for mobile application. While in [108], they designed some GSM for communication because it serves a small area and mobile application. On another side, the first project depends on a monitoring system that could be used in a large area for patients' movements, but in [108], the idea behind the project is to serve POD room inside the hospital for real-time monitoring system both papers focused on health care area as we saw but in a different situation.

In [105] and [106], they designed IoT projects that present intelligent city facilities. In [105], they used a CCTV camera, and according to image recognition, they analyzed traffic on the road by sending and detecting frame for estuation the time that cause traffic. By Raspberry-Pi and firebase as backend database notification, they implement their design. On the other hand, in [106], the authors used Arduino instead of Raspberry-Pi and MQ4 Gas Sensor to detect toxicity level of dustbin in the city. This paper focused on helping Municipal, and citizens detect the level of unwanted gas and trash in the dustbin. Both projects are connected to CCTV camera and send notification for car, whereas in [106], could send notification also for house or shelter near the dustbin.

IX. CONCLUSION

This article offers a detailed review of the most recent research that have been carried out on the Internet of Things (IoT) from a commercial perspective. After establishing the backdrop of Enterprise Internet of Things (E-IoT), IoT technology, and IoT service-oriented architectural models, the next step is to discuss the fundamental technologies that are applied in the Internet of Things (IoT). After that, we'll go through the most significant applications of the Internet of Things in business. After then, we spoke about the recent developments in the Internet of Things (IoT) research as well as its possible future development paths. The earlier assessments of the Internet of Things tended to cover a broad variety of issues, but this one concentrates only on the applications of the Internet of Things in the industrial sector, stressing both the obstacles and the opportunities that lie ahead for future researchers in this area. With the support of the Internet of Things, device manufacturers have the potential to boost device efficiency in settings that are both globalized and distributed. IoT is still in its infancy despite the fact that it is starting to be used by ESs. Communication and decision-making that is stable, safe, and efficient need more research in a variety of fields, including modularized and semantic integration, standardization, and the creation of tools to enable these endeavors.

Enhanced Internet of Things (E-IoT) solutions are often pricey, closed source, and proprietary. This not only makes them more secure than commodity systems, but it also makes them more suited to the particular applications for which they were created. Surprisingly little attention has been dedicated by researchers to the subject of the security of E-IoT systems, despite the fact that these systems are used extensively. To be more specific, there is no study that provides a thorough analysis of E-IoT systems,

which includes all of the components, risks, and vulnerabilities connected with them. In this research, a broad variety of studies that have integrated and influenced IoT technology were reviewed. Some examples of these studies include healthcare, smart homes, smart cities, assisted charities, and monitoring systems. The computer systems, including hardware and software, that were used to conduct each of the studies were also included in the paper. In addition to that, the testing and evaluation process used in these publications is quite precise.

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