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Internet of Things Applications: Opportunities and Threats

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Abstract
In the century of automation, which is digitized, and more and more technology is used, automatic systems' replacement of old manual systems makes people's lives easier. Nowadays, people have made the Internet an integral part of humans' daily lives unless they are insecure. The Internet of Things (IoT) secures a platform that authorizes devices and sensors to be remotely detected, connected, and controlled over the Internet. Due to the developments in sensor technologies, the production of tiny and low-cost sensors has increased. Many sensors, such as temperature, pressure, vibration, sound, light, can be used in the IoT. As a result of the development of these sensors with new generations, the power of the IoT technology increases, and accordingly, the revolution of IoT applications are developing rapidly. Therefore, their security issues and threats are challenging topics. In this paper, the benefits and open issues, threats, limitations of IoT applications are presented. The assessment shows that the most influential factor for evaluating IoT applications is the cost that is used in 79% of all articles, then the real-time-ness that is used in 64%, and security and error are used in 57% of all reviewed articles.

Keywords Internet of things · Smart manufacturing · Industrial IoT · Future technology · Threats

1 Introduction

The rapid development of technology makes human life easier with each passing day and allows us to meet needs in many ways. When the subject in question is needed, we are confronted with an endless process, and this situation paves the way for continuous development. The term industry 4.0, widely used today, also refers to a range of technological developments. It reflects the evolution of communication technology in this universe, where sensors, devices, machines, production processes, and even factories contact each other [30].

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There is a concentration on robot technology. Inanimate beings, such as collecting data from the environment, communicating with each other, and transferring data, often occur without human intervention. In the future, when the human element takes over, the system will be outnumbered. It is also possible to evaluate artificial intelligence applications, which demonstrate development by imitating human thought. In this context—considering which of the alternatives that computer systems prefer to focus on right or wrong results, adapt them according to these choices, and finally, dress into a 'humanized' structure as a thought.

When we look at the history of the IoT concept, we see that products with the IoT concept are gradually developing. Products such as smart wristbands, smartwatches, smart glasses, smart t-shirts, smart rackets, home automation systems, smart cars, and many more. A Cisco report [2] predicts that by 2030, approximately 500 billion devices will be equipped with sensors and connected to the Internet.

This large number of devices with smart sensors constantly monitor and collect information from the environment, and this data is sent to cloud servers for storage and evaluation. When the user requests information through applications, the processed data is provided to the user quickly and structured [2].

With investments made on objects, all of them will soon be connecting to the Internet via Wi-Fi and Bluetooth technology. Smart products will also enter the Internet through drones other than modems located nearby and transmit notifications to users.

The industrial revolution that started with the invention of the modern steam engine powered by coal by James Watt followed the use of electricity and oil in mass production, and the fourth industrial revolution was reached with the spread of the Internet and the IoT [30]. The IoT concept was used for the first time by Kevin Ashton in a presentation on the benefits of Radio Frequency Identification (RFID) technology for P&G in 1999 [5]. However, the first IoT application in history was the sharing of images of a coffee machine with a camera system over the Internet by a group of academics at Cambridge University in 1991.

Traditional internet communication infrastructure connects end-users with different communication systems. With the new developments in technology, many sensor devices can be integrated into the internet environment via WSN (Wireless Sensor Networks) [22]. Continuous and real-time data flow coming from the sensor devices monitoring of the elderly, tracking traffic flow, security, transportation, and so on.

The IoT concept owes its development mainly to these technologies in sensor devices. It is possible to monitor almost all events around us with these devices. However, to store the data (big data) produced by these devices, there is a need for large-capacity storage platforms, software that can analyze this huge od data using big data analytic algorithms, and easy-to-use web services that will serve as a user interface. Therefore, IoT applications need public cloud services. The specialized cloud services could be developed to continuously collect data from WSNs and send the result over the web by analyzing data rapidly when a user request is received [19]. Hence, the security issues of IoT applications become a challenging problem.

The contributions of this paper are as follows:

- Presenting the benefits and the open issues of IoT applications
- Offering opportunities and threats of IoT applications
- Explaining the limitations of the IoT applications

The organization of this paper is considered as follows: The related work and classification of articles are presented in Sect. 2. Section 3 covers our research method. The organization of the IoT applications is investigated in Sect. 4. Section 5 discusses some of the open issues, the limitations, threat problems of the IoT applications that need to be addressed in IoT applications. Finally, Sect. 6 concludes the paper.

2 Related Work

Dijkman et al. [12] discussed the general structure, architecture, and areas of IoT platforms being used commercially. They also revealed that these platforms have different functional features.

Malik et al. [30] presented a review based on industrial automation, which is spreading rapidly, is combined with internet technology, and is heading towards the age of smart production.

Woodside et al. [26] presented the importance of applications in the smart industry. In this review paper, the main advantages of IoT in the smart industry are classified. Furthermore, they conducted a study on how smart transportation systems can be made more effective with IoT applications within the framework of the studies on smart transportation systems.

Yang et al. [23] presented a modified task technology for use in the emergency management community. They used IoT technology combined into the three rhythms: mobilization rhythm, preliminary situation assessment rhythm, and intervention rhythm to improve emergency response operations.

Also, we examined the studies in IoT applications with a focus on security. Our investigation is listed in Table 1, consisting of the first author's name, publication year, the main idea, advantages, disadvantages, and new findings of each article.

3 Research Method

We used the following databases: Elsevier, IEEE, Springer, and MDPI to find relevant studies for surveying. After that, we selected 37 articles to review.

This paper answers the following Analytical Questions (AQ) that constitute the objectives of the problem:

AQ1: What are the main features of IoT applications?
AQ2: How can we summarize the IoT limitations?
AQ3: What are the benefits of IoT applications?
AQ4: What are the open issues of IoT?
AQ5: What evaluation factors are used in assessing IoT application methods?
AQ6: What are the current and future threats and limitations of the IoT applications?

Figure 1 indicates the distribution of research through publishers. It means research papers published by a major scientific publisher related to the research method.

Figure 2 shows the percentage of published research papers by different publishers. As shown in the figure, the highest percentage is the Elsevier with 36%. The sequence continues with IEEE 28%, Other publishers 23%, MDPI 8%, and Springer 5%.

Table 1 Classification of recent studies and other information in IoT applications

Research	Main idea	Advantage	Disadvantage	New finding
Cho et al. [8]	Proposing an appliance-aware activity recognition mechanism for an IoT energy management system Proposing an intermediate management service layer for the conformability of household appliances	Establishing communication services among various appliances Providing energy management services Improving the efficiency in saving household electricity	Lack of generic implementation Security issues Incompatibility of devices that are not supporting network functionality of IP with this system	Providing a system that can identify home activities, and notify users about an unused appliance, or turn them off automatically Improving the usage behavior of appliances through a remainder
Felisberto et al. [14]	Proposing a solution for monitoring the elderly Using the fusion of sensory data	Low-cost deployment High precision of the system	Defecting in the detection of more complex falls	The precision of the system in identifying body postures and movements allow for a valid monetarization and rehabilitation of the user
Fang et al. [13]	Introducing a novel IIS for regional environmental monitoring and management based on IoT	Increasing the efficiency of the monitoring system Improving decision making	Management of big data is challenging Complexity Security issues Multi-source data collecting Heterogeneous sensing	Providing a prototype for environmental monitoring and management
Ashokkumar et al. [4]	Presenting a vehicular data cloud platform using cloud computing and IoT	Optimizing traffic control	Huge damage due to breakdown Data leakage such as location Need to integrating different technologies of devices	Intelligent parking cloud service Vehicular data mining cloud service
Gutierrez et al. [18]	Demonstrating how the IoT integrates with GIS using electronic engineering to improve urban management Presenting solutions for the collection of municipal waste with the help of the IoT	Boosting up the efficiency of municipal services Reducing costs Improving decision making in city management Improving traffic congestion Balancing cost-efficiency functions	Deploying this system implies high total costs	An optimization process allows creating the most efficient collection routes

Table 1 (continued)

Research	Main idea	Advantage	Disadvantage	New finding
Hossain et al. [19]	Presenting monitoring framework for sending health data securely Analyzing data by third-party software if needed	Reducing clinical error Providing patients well-being and safety Capturing real-time patient's data Reducing cost Reducing the interaction between patient and staff Pervasive access to quality care	Security and privacy issues Dependency and malfunction of devices Lack of option for a cloud server to extract features and classify signals	Describing cloud-integrated health-IIoT monitoring framework Watermarking data before sending it to the cloud for data security
Jacobsson et al. [21]	Conducting a risk analysis for a smart home automation system Examining 32 risks of smart home and classifying them	Energy saving Remotely control electronic devices Monitoring energy-consumption Safety surveillance cameras	Complexity Heterogeneity of interconnected services Lack of model of security and privacy to design a smart home	High risks are related to human factors or software components, so the risks are minimized to an acceptable level Reducing energy consumption for householder by gaining feedback
Abashidze et al. [1]	Combining IoT and The Web of Things (WoT) to Increasing sales capacity Improving decision-making process in different phases of the purchase process	Increasing cognition of the product Increasing customer interaction with the product Increasing customer freedom in product selection Increasing competitiveness Increasing consumer loyalty Reducing customer distrust	Security and privacy issues Data leakage Dependency and malfunction of devices	Guiding to integrating IoT and WoT to create marketing opportunities Providing a new style of marketing to reduce customer distrust Checking brand value level
Wei et al. [31]	Monitoring health signals transmitted to the doctors The sensors on the human body can form a network	The mobility of users The complexity of the environment Security issues because of frequent user interaction Increasing the lifetime of nodes The common postures for users can be described	Lack of 5G the route paths face frequent changing topology and many breakages Lack of the integration of heterogeneous networks	Build a disaster rescuer health monitoring system Providing effective routing repair solutions for route breakage Forecast three most likely directions

Table 1 (continued)

Research	Main idea	Advantage	Disadvantage	New finding
Chaudhry et al. [35]	Proposing an IoT-based real-time system for livestock health monitoring Providing a dashboard of services Predicting animal disease	Monitoring the cattle in real-time Investigating influencing livestock health Providing mobility and user convenience in real-time	The necessity of the Internet in non-covered areas Low energy autonomy Requiring a large dataset to build a model Less accuracy in predicting some behaviors	Designing a multi-sensor board to record several physiological Parameters
Ding et al. [32]	Designing a virtual reality system for physical education using the IoT, cloud platform, and mobile client	Improvement of teaching level Improving the response time Increasing user satisfaction	Large number of renders limits the running environment Lack of convenient and economical method High cost	The virtual reality system can establish a distance education information system
Jia [37]	Planning and designing of smart gardens Combining field research and project practice based on theoretical analysis	Increasing the added value of agriculture Increasing the economic income of farmers Improving the economic benefits of rural areas Promoting the construction of a new socialist countryside	Lack of unified standard and system for the smart garden Lack of an advanced method of data processing Low precision or accuracy	Providing scientific guidance for the agriculture of the smart garden
Mabrouki et al. [36]	Designing an automatic weather monitoring system Measuring and controlling the environmental parameters Predicting the future stations of weather	Facilitating human work Making life easier than before Measuring all environment parameters remotely Less expensive Decreasing power consumption Automatic decision making	The necessity of the Internet in non-covered areas	Observing of contamination in modern urban areas Protecting the general well-being from contamination

Table 1 (continued)

Research	Main idea	Advantage	Disadvantage	New finding
Mircea et al. [33]	Describing a smart education environment Identifying the more efficient type of education	Providing smart interactive classrooms Real-time reporting on the students' cognitive activities	Requires staff knowledge to adapt to the new system Integration with the national education systems	Influencing on intra- and extra-university connectivity Increasing connectivity between students, the academic staff

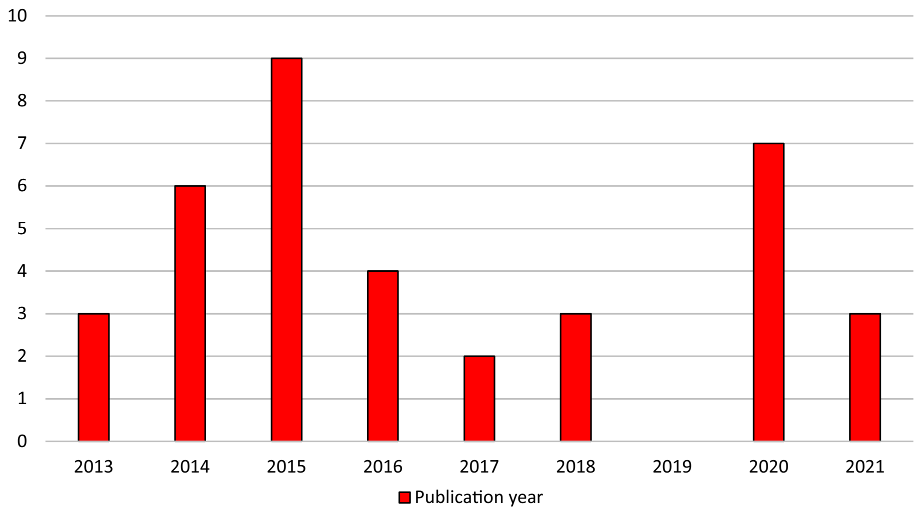

Fig. 1 Distribution of research papers by the publisher

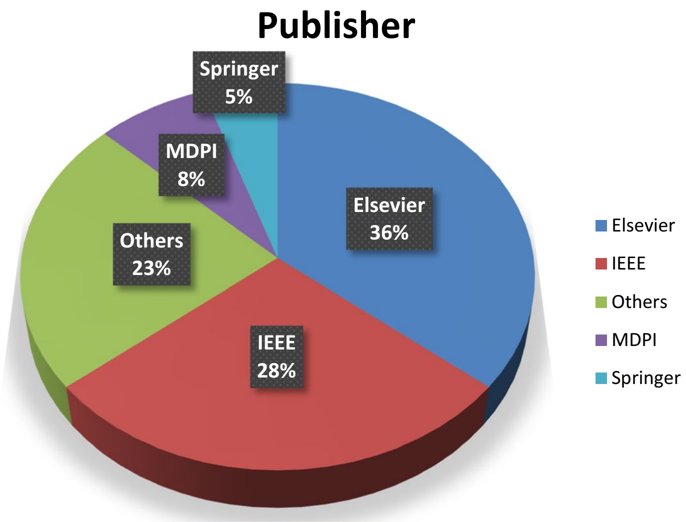

Fig. 2 Percentage of published research papers by different publishers

4 Organization of the IoT Applications

The foundations of IoT in the early 1990s can be traced back to Weiser's (1993) Theory of Computing Everywhere. However, the first person to use the term IoT was Ashton from the MIT RFID research collection [5].

IoT is a phenomenon that today surrounds all aspects of human life and has created a chain of interdependent beings. It is so intertwined with human life that today it is very strange and difficult to imagine a lifestyle without smart applications and intelligent sensors and tools.

In factories, large quantities of materials carrying RFID tags in production areas provide a great convenience in process management. Information received automatically with RFID readers in a data network environment while hiding it can initiate a different process that will activate another smart system. Smart sensor devices used in IoT can introduce themselves, establish a network, transfer the information they collect publicly to cloud services that can store and analyze [15].

IoT applications' extent manifests in individual dimensions, lifestyle, and healthcare, such as smartphones and smartwatches, and large and industrial dimensions. Users can access these services and get the analysis results they want via easy-to-use web services.

Rapid developments in IoT have attracted the attention of companies trying to increase production quality and efficiency. Sensor units communicating over wired networks, programmable digital control devices (PLC), and embedded systems are used in production. These systems are controlled from the control center by SCADA (Supervisory Control and Data Acquisition) or DCS (Distributed Control Systems) systems. They are mostly independent of local network systems or the Internet.

IoT has quickly become a necessity globally and has created a system of humans, objects, data, and processes that exchange quickly.

Machine-to-Machine (M2M) networks are a type of network formed by direct connection through a channel between two machines, wirelessly or wired. It is estimated that by the year 2022, the number of M2M networks will reach about 8.5 billion that half of them will be derived from automation appliances, tracking applications, and security monitoring [28].

IoT applications in various sectors, including smart cities, smart industries, smart environment, healthcare, and education, have improved the quality of human life. Essential data are achieved from the smart sensors of these applications, stored in cloud computing environments by creating big data. They are processed by machine learning methods and contribute to significant trends.

Artificial intelligence used in IoT applications can make the best decision in the shortest time by fetching past stored data and comparing the process of change in complex conditions with much faster and more accurate processing than human intelligence. As a result, humans can enjoy IoT application services in all activities anytime, anywhere with incredible speed and quality. Services fall into several categories, and we study each type in more detail.

4.1 Smart City

Smart cities can be defined as a city that uses digital technologies or information and communication technologies to improve living style. It can also have the effect of changing our living habits. In this study [16], the difficulties in reaching the opportunities are discussed, and how a smart city can be developed. Several components of smart cities are shown in Fig. 3.

The main applications in smart cities are:

- Smart parking systems that detect empty parking spaces in cities
- Monitoring systems for vibration and material conditions in bridges and historic building

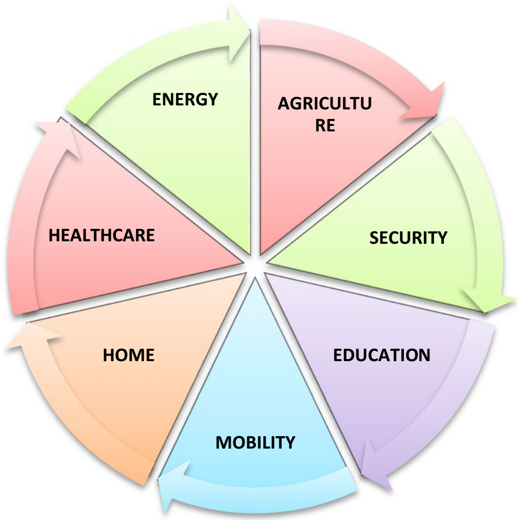

Fig. 3 Smart cities components of IoT [16]

- Noise mapping in real-time in central areas such as bar areas and city centers
- Smart traffic applications that detect traffic congestion due to climate or accident and offer alternative routes to vehicles and pedestrians
- Smart street and highway lighting that adapts itself to weather conditions
- Waste management systems that detect garbage levels and optimize garbage roads

Smart cities have begun to emerge today. Some of them find distribution opportunities with municipal access networks for all maintenance services and city management that require data connectivity. In practice, it shows how the IoT can contribute to the development of city management systems by integrating data access networks, Geographic Information Systems, unifying optimization, and electronic engineering.

Nowadays, wireless sensor networks in smart urban infrastructures have led to a large amount of data produced every day, especially environmental, health, and traffic monitoring services. Therefore, there is a need for new methods and techniques for effective data management to create and analyze data to help manage intelligent and dynamic resources. Dempster-Shafer Uncertainty Theory offers semantic web technologies and multi-level intelligent home architecture. The proposed architecture is described and explained by scenarios that are aware of the functionality and real-time context [16].

In this study [18], a communication-based waste collection solution about garbage bins was presented by reading and collecting garbage volume data over the Internet and using an embedded IoT prototype equipped with sensors. Experiments were conducted to investigate the benefits of such a system compared to traditional waste collection approaches, including economic factors. Such Opportunities were created by such initiatives to develop smart city solutions and contributed to third parties with a realistic scenario by taking open-source data from Copenhagen city.

There are also applications using the IoT platform in modern agriculture [37]. These practices include soil-free agriculture, monitoring soil moisture and stem diameter for the control of plant health and sugar content in fruits, studies to maximize fruit and vegetable quality and production by controlling micro-climatic conditions in greenhouses, control of moisture and temperature levels in hay and straw, selective irrigation activities in dry regions in terms of efficient use of water resources, especially forecasting frost, snow, rain, drought and wind changes, and examining weather conditions.

4.1.1 Smart Home

IoT applications used for home automation are mainly studies on water and energy consumption. Besides, remote control applications primarily attack, and burglar detection systems for museums are installed. While installing these systems, they bring along some risks. Security and user privacy of home automation systems are the most critical risk factors. A total of 32 risk factors were determined in a study, four of which were defined as severe risks. These severe risks are risks linked to software components and human behavior: risk analysis, security, privacy, security, and privacy design. Security and privacy must be integrated into the design phase to eliminate these risks [21].

All objects in the home automation system communicate with each other via wireless networks or wireless sensor networks. A machine-to-machine (M2M) application-based smart home and security system can be set up for these communications [6].

It is possible to collect control information about all environment sensors and devices used in the home at the center (even in service on the Internet) through a communication medium. Subsequently, analyze this information to increase home security, ensure effective energy management, or use it for other purposes.

Smart building and cloud computing-based technologies can be used in IoT object building and facilities to cooperate and work efficiently with various detection devices. Building management systems is essential to reduce the large amount of energy consumed by smart buildings. With the cloud-based building management system installed, computer resources and storages choose the optimum device feature [24].

4.1.2 Smart Transportation Systems

The transportation system plays a decisive role in urban development. The entrance of IoT intelligent systems into the transportation and logistics sector has led to improvements in traffic monitoring and control, supply chain systems, and timely decision-making in particular circumstances [34]. Moreover, this system is one of the densest systems in terms of the number of devices. Equipping these many devices with applications for access to the Internet, automatic parking, driverless driving, and navigation, It will make it the fastest-growing part of the industry.

It is predicted that a large number of interconnected devices in this system will cause global M2M IP communication to grow by 21.3 EB, from 3.7 EB per month in 2017 to more than 25 EB in 2022. This growth will generate more traffic than multiple connections due to the increased use of video applications from M2M connections. Therefore, this trend will occupy almost 45% of global IP traffic by 2022 [28].

Security is one of the biggest challenges associated with transport systems. Accuracy, integrity, and confidentiality in data transferring, system components availability, and correct delivery are essential in the intelligent transportation system. The use of Blockchain technology to integrate distributed information and maintain confidentiality greatly contributes to the growth of this system [34].

Smart parking, smart routing, etc., are the opportunities in a smart city with an intelligent transportation system. Also, driverless assistants are the charms of a modern city with an intelligent transportation system.

4.1.3 Smart Shopping Area

IoT in the shopping area has become widespread, especially with Near Field Communication (NFC) technology in mobile phones and the increase of applications such as e-Wallet. Figure 4 shows IoT devices installed worldwide from 2015 to 2025 in billions [27].

As shown in Fig. 5, while Global Industry Marketing will reach $87 million in 2019, according to research, it will increase by an average of 37% in 2023, and the budget is expected to reach $310 million [41].

Main applications in shopping areas are public transport vehicles, sports halls, amusement parks, etc. Therefore, NFC payment transactions in location and the activity-centered regions are:

- Smart shopping applications that can advise customers according to their habits, preferences, as well as allergic components for them
- Smart product management systems in the rotation control of products on shelves and warehouses to automate inventory replenishment processes
- The supply chain for product tracking is supply chain control applications that enable monitoring the product.

NFC technology is a contactless short-range radio communication that allows data to be exchanged between devices such as personal computers, personal digital assistants, smartphones. However, the NFC ecosystem claims to have third parties and the lack of a

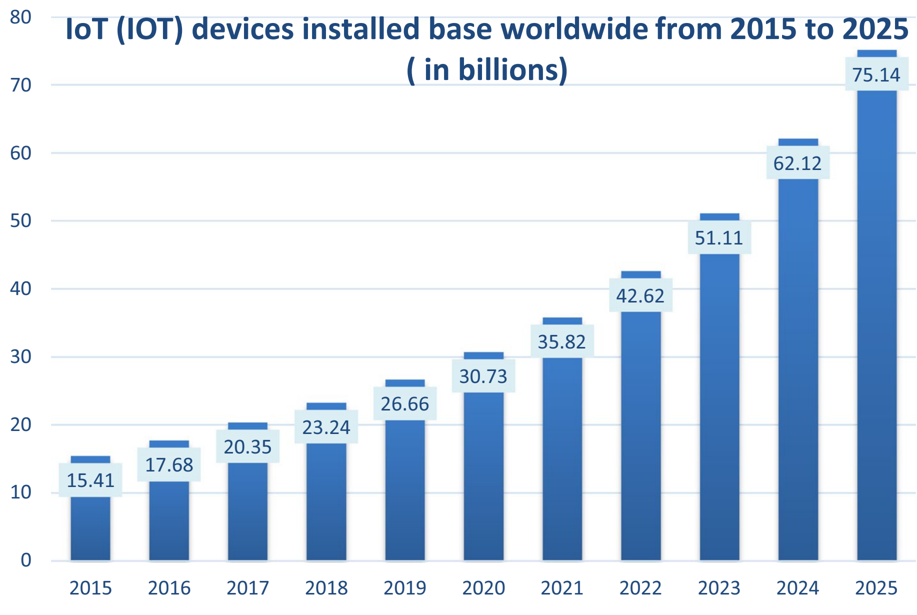

Fig. 4 IoT devices installed worldwide from 2015 to 2025 in billions [27]

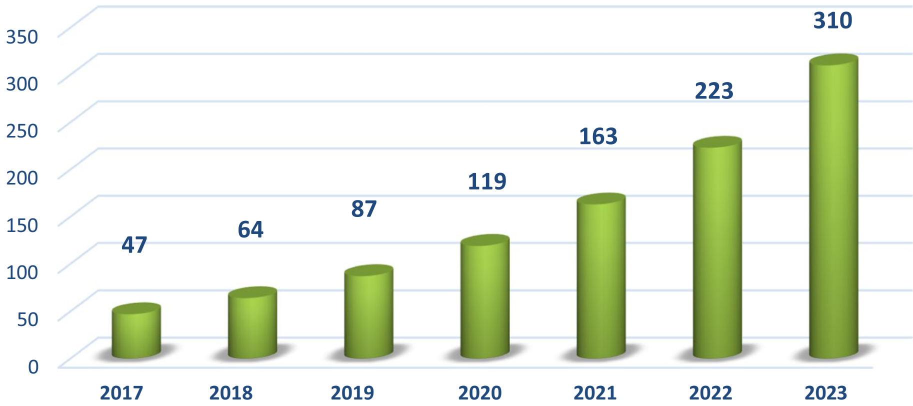

Fig. 5 Global industry Market size 2017–2023 [41]

common standard, all parties to access customer information such as bank account information, which affects the security of the technology.

The dynamic relationships of the parties in the NFC transaction process share their access permissions in the applications running in the service environment, making them familiar. However, these parties only have the right to access their parts and are not aware of the rights and access permissions of the other parties. The lack of information between the parties complicates the management and ownership of the NFC ecosystem. A security module called Secure Element (SE) was designed to be the secure base for NFC to solve this problem.

One of the technologies used to perform secure NFC operations is cloud computing, a wide range of positive qualities compared to SE as a single element in a mobile phone that protects NFC. In addition, cloud computing can solve many problems in terms of NFC application management.

4.2 Smart Industry

Smart industry is named the industrial evolution. Electronic systems and information technologies have become fully automated with the digital revolution that started when production has become fully automated. Industrial automation, which is spreading rapidly, is combined with internet technology and is heading towards the age of smart production called Industry 4.0 or the 4th Industrial Revolution [30].

The integrated application of IoT and industrial automation systems is called Industrial IoT (IIoT). IIoT combines real-time data analysis consisting of big data, IoT, machine-machine communication, cloud computing, and interconnected sensors [19].

IIoT applications can be systematized as follows: indoor air quality measurement and improvement systems allow everyone to look at toxic gas and oxygen levels inside to protect workers and products, thermal control for sensitive products, especially in chemical plants, industries, or medical fields, robot applications. Wearable technologies are active, passive detection systems such as RFID, NFC tags such as Zigbee, which are used for monitoring ozone levels in the meat drying process in food factories, and indoor location detection [13].

With the revolution of the IoT and the increasing influence of robots in many areas of life, robotic systems that continue with the IoT are the primary reality of our near future. For this reason, new advanced services for interaction between robots and objects have been designed to help people. However, several essential issues, security issues, design techniques, and powerful architectural pieces need to be considered to increase the robotics applications realized with the IoT. Therefore, all research focuses on technological impacts, open issues, and robots working primarily in the field of the IoT [9].

The smart industry combines the sensors of the IoT with the industrial infrastructure to automate many Internet activities. In the smart industry, the information collected through the IoT system is also used to change the manual system. For example, business intelligence provides a model for the direct evaluation of workers in an industry. This model uses data collected through sensors located in an intelligent industrial system to select different industrial processes for workers.

If the employee and the activity are together, they are added to the process. Therefore, this model collects the location data of each employee and calculates the positive, negative, and neutral processes about the location data. Hence, the information obtained is used to select cognitive decisions for employees working on game theory. This experimental study compares the employee evaluation system manual to the proposed model. The response of an automated system to employees is then evaluated both empirically and mathematically. Finally, it shows that the model correctly assesses employees and that employees respond positively to the sector. The model also accelerates the evaluation system and intelligent industry decision-making of effective and efficient cognitive workers [25].

Tracking the dismantling process is essential in estimating the practical recycling rate for scrap vehicles at recycling centers. Scrap vehicles are valuable resources in urban mining and must be 95% recyclable by law in South Korea. Each smart car carrying scrap vehicles is equipped with a load cell for weight determination, RFID for tag identification, and Zigbee for wireless communication. When scrap vehicles are loaded into these smart vehicles for disassembly, the carrier vehicle is registered with the scrap vehicle. Required dismantling instructions are displayed on the station's computer monitor based on the vehicle part database. The developed system was implemented in a recycling center headquartered in South Korea. Dismantling processes at each workstation can be viewed in real-time over the Internet. In addition, dismantling results of the parts are stored on the computer server for future verification [29].

4.2.1 Smart Agriculture

Smart agriculture systems are mainly used in greenhouses where indoor and environmental information can be relatively controlled and the most suitable for cultivating different agricultural products. Smart agriculture planning and designing were formed from the combination of IoT applications and the agricultural landscape. Monitoring of agricultural spaces, measuring vital plant growth factors, the impact of fertilizers and nutrients on soil fertility, measuring the chemical elements of the breeding environment and identifying contaminants in the soil and air, warning in particular conditions, and analyzing the general situation by IoT components and applications are the effects of this technology in the field of agriculture and horticulture.

In this system, it is only necessary for a user to determine environmental factors and perform periodic sampling so that the collected information is automatically transferred from the sensors to the host computer and higher output. Then, the application intelligently makes decisions and executes commands by processing data and analyzing the situation [37].

4.2.2 Smart Livestock

The fundamental role of livestock in the supply of protein and dairy products and common diseases between humans and livestock is one of the human motivations for improving this industry [35].

The extent of livestock breeding and related industries such as leather and pharmaceuticals has led humans to use technology to increase the speed and quality of this industry. With the development of IoT applications, changes have taken place in the livestock monitoring system. Farmers often notice abnormal changes in the animal's body by measuring the body temperature, heart rate, and acceleration. Imagine on a huge scale how these factors can be measured and monitored manually by manpower.

Using various movable and fixed sensors and interconnected microcontrollers, livestock's environmental and physical conditions can be continuously measured, which is a great help in preventing livestock disease and subsequent transmission of the disease to humans. Today, by wearable collar devices, these factors are constantly being measured. Various mobile sensors such as pulse sensors, temperature sensors, accelerometer sensors, thermometers, etc., are installed in one collar mount on the animal. At the same time, the user can easily monitor the condition of the animal with a microcontroller connected wirelessly to this device [35].

4.2.3 Smart Logistics and Vehicle Tracking Systems

Importance using IoT applications in logistics and transportation are: monitoring of transport activities, vibration, impact, an inspection of container spaces and refrigerated warehouses for insurance purposes to ensure the quality of transport conditions, protection of flammable goods close to substances in explosive containers, fleet tracking systems for road control medical drugs, jewelry or sensitive goods such as dangerous goods.

The ways used to control product flow in logistics are mainly information systems such as Warehouse Management System (WMS), European Rail Traffic Management System (ERTMS), or other legacy systems. With the advancement of cloud systems and IoT, the division, transfer, storage, operation, and transmission of related information and events have also been introduced. It is also reported for better communication and interconnected development in the supply chain of logistics flows. It also provided collaborative platform architecture based on advanced technologies related to cloud systems, GPS, and RFID to address these issues [17].

Recently, many approaches have made suggestions for estimating travel time, most of which have focused on estimating travel time on highways and in simple arterial networks. In the study [11], a data-based real-time travel time estimation model that combines real-time and historical travel time signs is proposed to transform travel forecasting time rules and find traffic patterns from raw data in database services. It is also proposed to combine the main weights of all dynamics by the meta-rules to create a real-time traffic response mechanism to increase the accuracy of travel time estimates.

Furthermore, mapping several GPS trajectories from noisy observations aims to restore original routes on a road network. A feature extract for spatial mapping and a spatial database feature extract are displayed in an ongoing study. The main results are obtained from the specific taxi GPS trajectories.

It aims to deliver messages to a targeted geographic area for many applications, such as geographic advertising, geographic broadcasting, and vehicle networks. It is a challenging task due to the mobility of the vehicle. Any vehicle can transmit a higher message to the target area when compared to the future orbit of the target area or the vehicle's trajectory. Based on research, a message delivery metric called coverage covers an important geographic broadcast message. However, when calculating the coverage, there was a severe problem due to the vehicle's lack of proper arrival time.

In the study, 2600 taxis followed the gamma distribution of a vehicle modeled travel time as a random variable with real GPS tracks. Travel time modeling helps to make accurate predictions by comparing vehicles. Numerous tracking-centered simulations have been performed, and the results show that the proposed approach is 37% comparable to GPSR, a single geographic route protocol, higher transmission rate, and 43% lower transmission costs [39].

Effective vehicle tracking systems are used to track the movement of any equipped vehicle from anywhere. The system uses a popular technology that combines microcontroller and smartphone applications. The system uses GSM/GPRS technology and GPS technology, one of the most frequently used automotive tracking systems. The position of the car is found by the built-in system and monitored in real-time.

A micro monitoring device is used to monitor the GPS and GSM/GPRS modules. The car's tracking system uses the GPS module to obtain geographical coordinates at regular intervals. The GSM/GPRS module retrieves vehicle data and updates the database. In addition, a smartphone application has been developed to monitor the condition of the car regularly [39].

Google Map APIs are used in the smartphone application to show the tool on the map. For this reason, users will be able to monitor the movement of vehicles using their smartphones continually and run the estimated time and distance for the specified target. This work presents the results of an experienced tool tracking system and some experience in practical application to demonstrate the appropriateness and effectiveness of the system. Therefore, users will continually observe vehicle movement using their smartphones and calculate the estimated time and distance for the specified target. In addition, this study presents some experiences with experimental vehicle tracking system results and practical applications to demonstrate the feasibility and effectiveness of the system [17].

The advantages of cloud systems and the IoT have provided a promising development to solve the annoyances caused by increasing transportation problems. A cloud platform was presented for new multi-layered vehicle data using the cloud system and the IoT technologies in a study. In addition, two innovative vehicle data cloud services were also evaluated, a smart parking cloud service and vehicle data mining cloud service.

Currently, many platforms are integrated with smart objects and their applications—however, none of these focused on on-road vehicles. IoT is based on the identification of real-world objects that connect them through communication interfaces. Such a simple idea has allowed knowledge in almost every field to emerge with many new applications. One of the essential areas of implementing the IoT is island vehicles, which currently have more than 50 sensors on average and can access sensors' information with a standard protocol.

In this way, vehicles have become real smart objects that can interact with other objects or any software system. To achieve this, it has been focused on Vitruvius, a web application-based platform where users without programming knowledge can quickly design and create and can use real-time data of vehicles connected to the system. The problem is that the sending of these data is out of control, the best time to send information cannot be determined, and the device that acts as a bridge between the system where this information is stored and the vehicle cannot send this information with the smallest possible resource consumption [38].

A study focused on the localization of objects with limited possibilities located in isolated areas. In particular, the scenario where the use of distribution or connection nodes becomes costly or practically impossible and the dependence of localization techniques becomes inevitable has been investigated. In more detail, the use of emerging IoT components such as smart gadgets capable of self-positioning or short-range communication has been advocated.

An essential advantage of the proposed scheme is that each intelligent vehicle overcomes collinear orbit problems from its movement in a straight trajectory. In addition, the Kalman filter is used to reduce the multi-hop position error in the positioning process. Simulations showed that using a positioning scheme with the Kalman filter reduces errors by 16% compared to the weighted average approach and 31% compared to positioning using a single direct connection. It also surpasses the layout with the Kalman filter typical range-based DV-Distance scheme with a constant fixed connection [20].

The atmospheric effects caused by troposphere and ionosphere delays must be predicted and modeled correctly to collect information on specific kinematic GPS in medium and large-scale systems. It may also be preferable to use multiple reference stations to increase the reliability of the solutions. GPS kinematic positioning algorithms have been developed for large-scale network environments belonging to the position speed-acceleration model in any process. Therefore, this algorithm can occur even in cases where the constant speed assumption is not implemented.

Predicted kinematic accelerations can also be used for air gravimetric. The proposed algorithms are implemented using the Kalman filter. The performance analysis and reference values of the reported algorithms were confirmed by comparing the results. The results show that reliable and similar solutions can be obtained at the position and kinematic acceleration levels using the proposed algorithms [40].

4.3 Smart Environment

Humans have been looking for ways to understand the environment from the past to the present. For example, they began to measure some environmental parameters with tools to predict the weather. But these traditional tools all had to be used locally. Today, with the intervention of the IoT, various environmental parameters such as temperature, humidity, pressure, chemical pollutants, etc., can be measured remotely with precise instruments and sensors in terms of chemical and physical quantities. Sensors record values and transmit them as electronic signals, and specialized intelligent and human systems make decisions based on this information [36].

Sensors monitor, measure, and process data at all times in the entire space and warn by comparing the current situation with the desired position [2].

4.4 Healthcare

One of the hottest topics in the world is the Internet of Medical things (IoMT). In the IoMT, there is always the concern of improving technology because a mobile user must wear devices. The type of topology, routing protocol, data storage tools, independence, and sensor power constantly changes and improves. High mobility of resources can lead to routing failure [31].

Nowadays, wearable devices have attracted the attention of various users, including athletes, stylists, and even ordinary people of different ages, from teenagers to the elderly. This is because multiple features in these devices that monitor the physical condition, activity level, sleep quality, heart rate, and blood oxygen level, etc., can be attractive to different age groups.

Today, the diversity of monitoring features, measurement accuracy, intelligence level, and user interaction among the companies that produce them have created a competitive advantage that has led to the growing technology of these devices. At the same time, the fashion industry always has a significant impact on marketing and the spread of devices [31].

Health and medical care are some of the main applications for IoT [7]. All applications in this area have shown the health benefits of the Internet. These applications include screening systems for older people in hospitals or at home, medical refrigerators for organic items for the elderly or disabled, vaccines and medications, athlete reviews in high-performance centers, and an example of a system that motivates people exposed to intense ultraviolet light at certain times.

Real-time or periodic health information such as blood sugar, blood pressure, heartbeat, body temperature, step count, instant physical condition, etc., can be obtained from the relevant medical devices. However, this information can only be monitored and analyzed by the physician and family, and urgent reaction in severe cases can only be achieved with an IoT based on the information system.

4.5 Smart Education Systems

Physical education has long been a common and efficient system in schools and universities around the world. However, research has shown that lack of diversity in the educational method and geographical constraints to attract students is a shortcoming. These shortcomings have caused the world to seek a new style of education in the physical education system. Furthermore, the speeding up of the Internet, the development of virtual reality technology, cloud platform, and intelligent communication tools have led the traditional education system to some extent towards distance education [32].

Recently, after the limitations caused by the epidemic of COVID-19, the very urgent need for virtual and distance education is evident in all countries, and educational spaces are seeking to improve the quality of intelligent communication tools [33]. All of this has resulted in a profound reform of the global education system. From all these threats and opportunities and the integration of computer technology with simulation technology, a new virtual reality technology emerged that had created a significant change in education. It has transformed the traditional educational system of the past into a modern educational system.

5 Discussion

The data accessed and obtained within the IIoT and IoT scope will also collect the necessary data that can be transferred from industrial systems related to production and manufacturing and use in the information system in the enterprise. Information systems with functions such as continuous real-time data flow from sensor devices in the environment and data terminals in production, storage, database, application services provided at a central point, or different cloud services. Smart devices used in production will ensure that decision support systems evaluate real-time information by minimizing human error.

5.1 AQ1: What are the Main Features of IoT Applications?

The main features of IoT applications are as follows:

- *Distributed intelligence* It aims to equip the smart device and network with decision-making and control capabilities that are not connected to a central control unit. Manufacturing machines operate autonomously to systematize operating frequencies and make decisions about energy efficiency. Smart manufacturing machines can indirectly fully communicate with other machines operating on the same production line, factory, and cloud system. When cloud-related manufacturing processes are developed, smart manufacturing machines can adapt to these changes in real-time.
- *Fast communication* It is essential to establish a fast communication infrastructure for real-time production in IoT applications. This situation necessitates the development of new communication protocols based on fiber infrastructure, especially for in-plant communication. OPC Foundation has published the OPC UA (OPC Unified Architecture) specification for protocols written to communicate machines (M2M Communication) to comply with specific standards.
- *Open systems and standards* The ability of production devices designed by different companies to communicate with each other and be programmed in a common language will enable developers of IoT applications to produce economical and flexible solutions without being dependent on a single source.
- *Real-time production and data transfer* These systems provide a rapid response to problems encountered in production, such as demand change and raw material supply. However, monitoring the information gathered from production in real-time will provide a significant advantage in competition and cost.
- *IoT analysis* IoT makes significant improvements in production quality, cost, energy efficiency, performance, reliability, thanks to its essential features:

    1. The sensor devices use the energy they need from batteries of wireless communication by providing the need. They can transmit information to their network.
    2. Since these systems are very cheap, they can be used in large numbers. Storage of collected sensor device data, different operations such as configuration, monitoring, or more detailed big data analysis. It is evaluated and analyzed using techniques and used in business decision-making programs.
    3. As a result of data analysis, the information received is transmitted to the right person.
    4. Corrective work for production is done quickly by the right people, loss of production uninhabitable.

With the IoT, up-to-date applications can increase the possibilities in all areas of our lives, starting from smart homes, cities, factories to applications in different fields of health and agriculture. It covers a vast industrial area.

5.2 AQ2: How Can We Summarize the IoT Limitations?

In IoT, the frequency range allocated for sensor networks to communicate with wireless networks is limited. Therefore, the development of dynamic cognitive-communication techniques has gained importance. Some of the shortcomings of IoT include:

As the number of connected devices increases and more information is transferred between devices, hackers' potential to steal confidential information also increases. In the end, businesses can deal with huge numbers—perhaps millions—of IoT devices, and it will be challenging to collect and manage data from all of these devices.

If there is an error in the system, every connected device will likely be damaged. In addition, because there is no international compatibility standard for IoT, it is difficult for devices of different manufacturers to communicate.

5.3 AQ3: What are the Benefits of IoT Applications?

While IoT information flow finds meaning with many applications that facilitate our daily life and business life, increasing the quality in production, reducing costs, energy by combining industry and IoT. Benefits of IoT are:

- To observe general business processes
- To improve the customer experience
- Saving time and money
- Increasing speed
- Integrating and stimulating business models
- Making better business decisions
- To get more income

It will create many positive effects on issues such as efficiency, performance, and the creation of competitive products. However, for these positive IoT attributes to benefit fully, they still need to be solved technologically and politically.

5.4 AQ4: What are the Open Issues of IoT?

Some of the open issues that need to be resolved in IoT are summarized below:

- *Data extraction and transformation into information* Studies on data mining and smart computing methods, which are current topics IoT show the billions of devices within its scope and the data they produce, will become even more critical.
- *Identification and identity management* Billions of sensors at IoT and smart devices will communicate. Therefore, it is mandatory to give a single name/identity to each object. Also, the management to solve this issue system needs to be developed.
- *Conformity and standardization in IoT* Many companies produce sensors and other smart devices. Each company has its technology, and as a result, devices from different manufacturers cannot work together. Compliance problems and the development of common standards are some of the most critical issues to be resolved.

- *Protecting the confidentiality of information* The IoT is open to attacks from anywhere in the world over the Internet. Necessary measures should be taken to prevent unauthorized access to objects.
- *Network security* Many sensors and smart devices will operate in large geographic areas in IoT. Possible against the object's physical and network protection methods and encryption techniques against attacks are insufficient.

5.5 AQ5: What Evaluation Factors are Used in Assessing IoT Application Methods?

The assessment of the evaluation factors for IoT applications in reviewed papers is shown in Table 2.

Figure 6 indicates that the most effective factor for evaluating IoT applications is the cost that is used in 79% of all articles. The next is real-time-ness that is used in 64%, and finally, security and error that are used in 57% of all reviewed articles.

5.6 AQ6: What are the Current and Future Threats and Limitations of the IoT Applications?

The challenges in the field of the IoT can be discussed in four categories: Technology, Architecture, Security, and Application.

Mobility is one of the main features of IoT applications. Considering the free movement of the application platform, frequent network changes and routing strategies, dynamic IP allocation, and network overhead are some of the challenges we face. These features cause the gateway to change, leading to a temporary service interruption in IoT applications.

An application serves a large number of devices. With different manufacturing technologies and communication protocols, many of these devices all served from a single

Table 2 Comparison of the evaluation factors for IoT applications

Research	Mobility	Complexity	Error-ness	Cost	Security	Real-time-ness	Availability
Cho et al. [8]	×	✓	×	✓	×	×	×
Felisberto et al. [14]	✓	✓	✓	✓	×	×	×
Fang et al. [13]	×	✓	×	✓	✓	✓	✓
Gutierrez et al. [18]	×	×	×	✓	×	×	×
Ashokkumar et al. [4]	✓	✓	✓	✓	✓	✓	✓
Abashidze et al. [1]	×	×	✓	×	✓	×	×
Jacobsson et al. [21]	✓	✓	✓	✓	✓	✓	✓
Hossain et al. [19]	×	✓	✓	✓	✓	✓	✓
Ding et al. [32]	×	×	×	✓	✓	✓	×
Wei et al. [31]	✓	×	×	✓	✓	✓	✓
Chaudhry et al. [35]	✓	×	✓	✓	×	✓	✓
Jia [37]	×	×	×	✓	×	✓	✓
Mabrouki et al. [36]	×	×	✓	×	×	✓	×
Mircea et al. [33]	✓	×	✓	×	✓	×	×

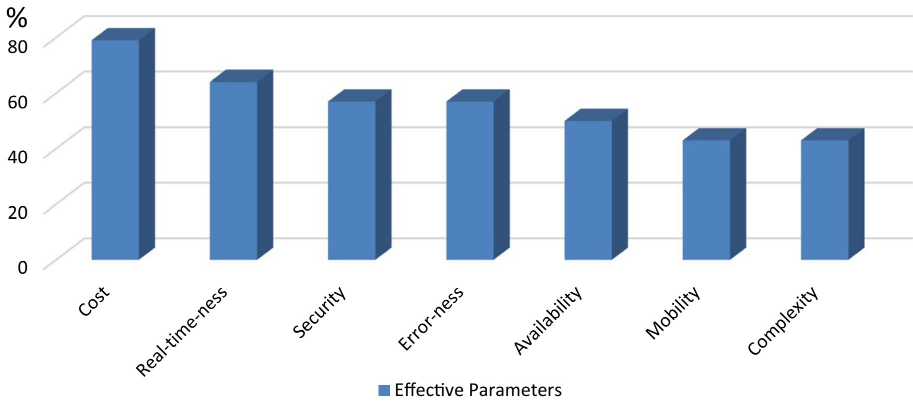

Fig. 6 The assessment of the evaluation factors for IoT applications

application in other geographical locations. Therefore, scalability is an issue that needs to be addressed. Integration of protocols and standards for overcoming this issue is not easy and cheap.

IoT applications often serve battery-powered standalone devices. However, battery failure or dying, lack of access to the mobile power supply can interrupt the service at a critical time. Therefore, it is essential to pay attention to the power supply of IoT components to receive high-quality service without interruption. Therefore, studies should be conducted to revision the battery lifecycle. Hardware redundancy and installing a spare battery, or even collecting energy from natural sources such as solar energy, could be an interesting solution that manufacturers should address in the future.

Availability and delivery of service in IoT applications need further study. In addition, service degradation due to lossy network, low-speed Internet, large data volumes, and network latency need to be solved. However, cloud platforms are an excellent way to overcome these problems and can be upgraded more and more.

Preserving security and confidentiality for data in IoT is critical because the IoT environment has many challenges due to its lossy or constrained identity.

Fifth-generation mobile communication systems (5G), was introduced to tackle the limitations and improve the performance of 4G. It supports an excellent data transfer rate with low latency and high connection density, transforming a wide range of technology and human life. 5G-enabled IoT communication environment will affect all intelligent fields, including medicine such as remote surgery, transportation systems like self-drive cars, virtual reality, flying IoT drones, and many more to communicate through the Internet.

However, despite the benefits, it has crucial challenges such as:

- *Privacy and security* In the 5G-enabled IoT communication environment, pervasiveness and expansion of intelligent systems, high speed of communications, and rapid access to resources, protecting the confidentiality and integrity of information is even more critical. More critical security and privacy issues in the future necessitate researchers proposing different types of security protocols to avoid or reduce the destructive effects of attacks.

- *Complexity and compatibility issues* IoT is made up of so many nodes that a defect in only one node will affect the whole system. Therefore, with the increasing growth of IoT, troubleshooting the system will become much more complex and time-consuming.
- *Reduction in the number of jobs* The rise of the IoT is gradually reducing the need for labor in the world. This is because intelligent systems think instead of humans, decide more accurately and faster than humans, and even more capable than humans.
- *Dependability* Technology surrounds all aspects of lifestyle, and human beings are becoming more and more dependent on smart devices. Therefore, there is a threat that if smart devices do not work correctly, there will be severe and irreparable consequences because the modern world has relied on technology and smart tools. Furthermore, as the intelligence of the environment increases, the destructive effects of their malfunctions become more serious. For example, a traffic light failure in a smart city can completely ruin the city [28].

6 Conclusion

In this paper, a screening study covering the application areas of the Internet of objects was conducted, such as healthcare, home automation, smart agriculture, smart cities, industrial control, smart environment, security, and emergencies. Due to the technologies and especially the cheapening and simplification of sensor technologies, it has become necessary to be in touch with all the objects we use in our lives.

It is a technological revolution based on dynamic innovation in several essential areas such as wireless sensors and nanotechnology, representing the future of the IoT, computing, and communication. Areas of application include a wide variety of industries such as management, electricity, industrial control, retail, utility healthcare. In a new expression defined as the future of the Internet, the IoT directs a new future surrounded by small smart objects that interact with the environment, communicate with each other, and are controlled over the Internet. It is thought that IoT technology will become the third-wave world industry after the computer and the Internet.

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