

# Studying the Importance of the Role of the Internet of Things and its Application in the Field of Health and Medical Equipment Industry

## Abstract

According to statistics, the Internet of Things is a rapidly expanding phenomenon that will shortly take over the whole planet. Iran is not immune to this issue. Like previous technologies, this one may present opportunities as well as potential dangers. Accordingly, the nation must be well informed when dealing with this technology and take the appropriate action. In reality, the Internet of Beings is a cutting-edge technology that was created as a consequence of the fusion and development of the Internet, wireless technology, and electronic-mechanical systems. It enables the connection of numerous physical items as well as living things.

The discipline of health and medicine is one of the many sciences and fields where the internet of things has a variety of applications. The goal of this study is to investigate and identify the challenges facing the health and medical equipment industries as well as the applications and functions of Internet of Things technology. The findings of this study will serve as the foundation for subsequent research to identify new IOT research opportunities. Researchers will get a better grasp of IOT research in the healthcare sector thanks to this study, which also raises awareness of business potential in the sector. This review can help practitioners realize fresh prospects that haven't gotten as much attention.

**Keywords:** *Internet of Things, health field, hospital*

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## Introduction

Information systems now play a more significant role than ever before, particularly in the healthcare sector (Pang, 2013). Information technology has always benefitted the healthcare sector, from electronic health records to cloud computing (IT). Information systems will be essential for enhancing healthcare and its administration as long as IT grows (Martinez Caro, 2010). Finding new business models to facilitate access to health care across all of the associated elements with a bigger information flow has become necessary as a result of this (Verdegum and De Marz, 2019).

The sector of health and medical equipment is one of the areas where the Internet of Things will be highly useful. Statistics indicate that this influence will be more pronounced and perhaps even more important in this field than in other ones. Many diseases may be detected remotely utilizing the Internet of Things in the medical area, and part of the treatment processes can be completed remotely and at home, reducing the need for numerous further hospital visits. Additionally, the convenience and accuracy of affairs have improved because of the intelligentization of information recording systems. As a result, many diseases can now be forecast, tracked, and treated at a macro level much more quickly. These IOT healthcare applications enhance patient well-being and save service costs, for instance by preventing unneeded hospitalizations and ensuring better care for those with specific needs. The whole value chain of the health sector and the medical equipment business will be transformed by IOT-based health services (Dey, 2017).

The purpose of this study is to offer more scientific solutions and responses to practitioners and scholars who are examining the impact of the Internet of Things on the healthcare and medical sectors. Indeed, the focus of our research is on whether IOT is influencing the healthcare and medical equipment sectors. Therefore, the purpose of this study is to determine how the Internet of Things (IoT) has an impact on the medical equipment market and the healthcare sector.

**Part one: Definition of the Internet of Things, its components, and its role in the field of medicine**

### **1. Definition of Internet of Things (IoT)**

For many years, one of the most fascinating subjects in the realm of communication has been the Internet of Things, or IoT. A vast network of linked parts makes up the Internet of Things. Internal communication between members of tiny networks is facilitated by the intranet of objects. Each of these little networks has unique characteristics that prevent communication between them. The Internet of Things was created as a result of unifying these communications' standards and protocols (IOT). In this network, connections and communication produce many outcomes. IoT is used to facilitate communication between people and objects. IOT may be described as a vast, extensive network that is linked following specific principles (Namazi, Kalantari, and Nizam al-Hosseini, 2015). The Internet of Things is a network of physical and non-physical objects that are equipped with electronics, software, sensors, network connectivity, and other features for data collection and exchange. Given this, the Internet of Things might be used in a variety of ways to help companies continue to expand and be productive. As a result,

it is asserted that the Internet of Things has a lot of predictive value in the development and enhancement of organizational performance (Dimitrov, 2016).

**2. Components of the Internet of Things:**

The information must initially be gathered by sensors before an Internet of Things device can be realized. Telecommunication platforms transport this information to the processing site, and the resulting information triggers the execution of the required command and action (suitable to the application). There are several divisions of the Internet of Things conceptually. Figure 1 depicts one of these divisions as having the following components:

1. The pre-processing layer of the medical device: the layer that offers information processing capabilities and is situated close to the medical device. In addition to gathering data, this layer also carries out the intermediate layer's directives. 2. The department of medical device communication is in charge of using middleware to link the device with other comparable devices. 3. The middleware part, includes API services, storage services, algorithm services, gateway services, and device management services. This section's goal is to examine the data created by the preceding sections and turn it into a usable data set for applications like reporting and analysis. 4. It is the information consumption layer, from which consumers and other players receive information (Tang and Wang, 2010).

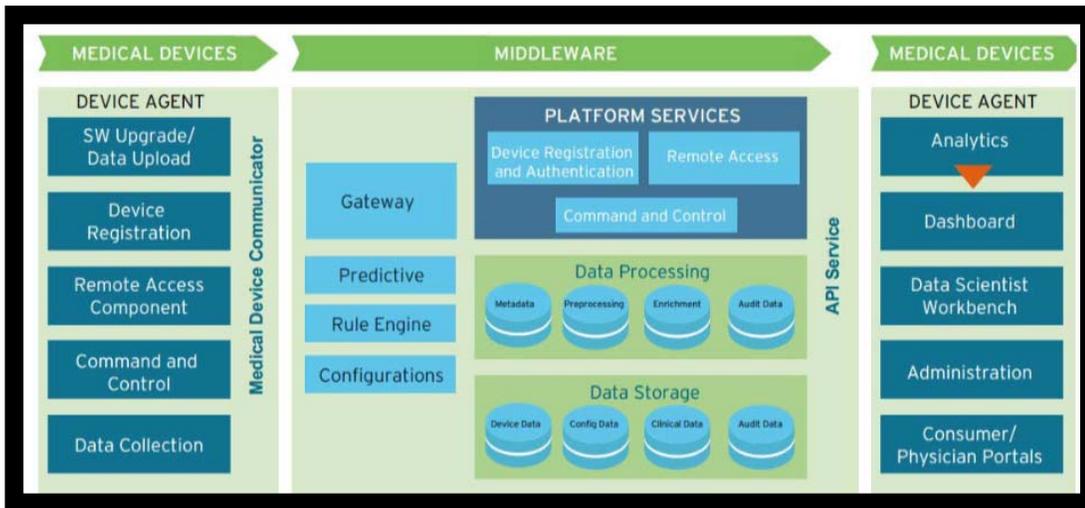


Figure 1. Components of the Internet of Things in the field of health

**3- IOT in the field of healthcare**

When Kevin Ashton attempted to use RFID tags to connect devices to the Internet in 1999, the Internet of Things was created (designed to make things easier for computers to manage). Studies have used a variety of IoT definitions. Others concentrate on the type of object (services and applications) and their scope of application (smart cities, traffic congestion, waste management, structural health, security, emergency services, logistics, retail, industrial control, and healthcare), while some prefer the type of connectivity (radio frequency identification, wireless sensor network) that connects various objects (Lee, 2020).

IoT has previously been applied in several industries, but it is a brand-new subject in the healthcare industry. Therefore, it stands to reason that medical institutions operate in heavily regulated industries. Due to the ongoing advancement of wearable technology and smartphones, many IOT-based health gadgets have made the conventional healthcare system smarter and more patient-centric. To replace the outdated hospital-centric experience with a new patient-centric operating technique, this intelligent system makes use of IoT advances. According to Bhatt et al. (2017), the Internet of Things (IoT) has transformed the healthcare sector by opening up new

avenues for e-health services and individualized mobile health services.

IoT is therefore described as a network of smart sensing devices and physical items that create a digital link in order to gather, monitor, and regulate health data in the field of medical equipment and treatment. Indeed, the patient data are quickly reviewed and examined by physicians and patients themselves thanks to diagnostic sensors built into the items we wear (such as gloves, wristwatches, spectacles, etc.) and connected to tablets or smartphones over wired or wireless networks (Farahani, 2018).

The significance of the function that IOT plays in many facets of health has been stressed by several studies. In a paper published in 2018, Dey and colleagues described how the Internet of Things (IoT) has improved illness management using a novel market-depth evaluation that covers vendor analysis, growth drivers, industry value chains, and quantitative assessment. According to Schaefer and Thomas (2017), IoT has made it possible for patients to automate clinical trials and has given the healthcare industry numerous valuable insights. Holler and his coworkers (2014) argued that the rise of IOT would lead to lower treatment sector costs as well as the development of novel treatment methods.

Moreover, IoT has given the healthcare sector a tool to boost productivity and efficiency. Hospitals have been able to combine different patient data and information even if they originate from other hospitals and centers that are part of the network by employing IOT efforts to improve information flow and ease contact with patients and their families.

### **2.3. Part 2: Internet of Things applications in the medical and healthcare equipment industry**

It is now required to respond to the issue of which areas of the health and medical industries the capabilities of the Internet of Things are appropriate. The Internet of Things will undoubtedly give users a lot of chances in the area of medical technology and care. The Internet of Things is "essential" for the future success of 89 percent of firms in the medical equipment and healthcare industries, according to a 2016 Vodafone poll. Furthermore, businesses that use the Internet of Things have had excellent outcomes. Additionally, according to their considerable returns on investment in the Internet of Things sector, two-thirds of the organizations who invested in this space have the following major applications:

#### ***1-2-3- Remote monitoring:***

For both patients and doctors, frequent hospital visits are expensive and time-consuming. Ten remote care options based on the Internet of Things are one of the ways to cut costs and time wasted. Remote monitoring lowers the need for emergency admissions as well as the number of visits and consultations by enabling clinicians to consult and evaluate patient data in real time. Patients may spend more time with their loved ones, physicians can see more patients, and they can swiftly debate difficult topics with their peers in institutions throughout the world. In emerging markets or rural locations with less convenient access to medical facilities and practitioners, remote monitoring can also be used. For chronic conditions including sleep apnea, diabetes, heart disease, and respiratory issues, remote monitoring is perfect and appropriate. According to certain estimates, the remote patient monitoring industry would rise to \$26.4 billion by 2030 (West, 2013). For instance, diabetic patients can utilize a smart gadget to broadcast their blood pressure and glucose levels to a distant clinic, where the staff can then use that information to determine the proper prescriptions and instructions. It is estimated that 642 million people would have diabetes by the year 2040 (Mohammadian and Zarei, 2014).

#### ***2-2-3- Independent living services:***

Millions of people worldwide are more susceptible than the average person. This group includes those who are elderly and those who have illnesses like insanity. In 2030, there will be 25 million dementia sufferers globally, according to projections. If they live alone, these folks are in grave danger. However, moving these individuals to care facilities isn't always economical. IOT-based solutions can close this gap and

make it easier for this set of individuals to function independently both inside and outside the home. In most cases, wearable technology and sensors may be used to execute this solution. By adopting this solution, senior people's everyday and routine activities are recorded, and in the event that they engage in odd conduct, such as keeping the bedroom light on at night, family members or others connected to them will be made aware of the problem. In this way, family members may live freely while monitoring their senior loved ones' conduct through a secure internet system (Rahmani and Radfar, 2012).

#### ***3-2-3- Production and supply chain:***

The subject of supply and production chain management is one of the areas where IoT is used. It has always been a top priority to guarantee the product's perfection and security throughout the supply chain. Due to the high cost of many health goods as well as their sensitivity to environmental factors, among other factors, this goal becomes more crucial in relation to health products. Also, because many of the items in the health industry are directly tied to human health, flaw and destruction in the majority of these goods are more harmful than defects and destruction in many other industries. Health items may be evaluated online using IoT techniques. Additionally, other concerns like the chance of theft may be decreased by utilizing these solutions. Large organizations can follow valuable commodities that are sensitive to humidity, temperature, and time in the field of health online thanks to tracking devices and sensors put in containers, warehouses, automobiles, and even the clothing of staff. IoT technologies may lower the risk of delivering medical supplies and assist in making the best choice when an issue arises (Suarez, 2016).

#### ***4-2-3- Clinical trials:***

One sort of medical research that is carried out on people in clinical trials. Clinical trials are crucial for understanding the effects of medications and novel therapeutic approaches. The consent of the health authorities or research ethics committee in the nation where this study is done, when a clinical trial for a medical product is conducted on people when compelling evidence of this product's quality and non-clinical safety has been gathered (Qasemi, Safari and Jokar, 2015). Clinical trials are seen as a particularly expensive component of drug research and development, even though they are very important. Typically, it takes 17 years for pharmaceutical companies to develop a medicine from the initial stages of fundamental research to a hospital product. Clinical trials may be completed more quickly and efficiently by utilizing IOT technology. Additionally, a deeper understanding of a treatment's success or failure may be attained by utilizing IOT technologies. Wearable technology is crucial to this solution. These technologies make it simple to gather and evaluate a vast amount of physiological data. The problems of taking part in clinical trial plans will be much reduced by adopting this

method, and it will be simpler to persuade participants to collaborate. As a consequence, the obtained data will be more accurate and enhanced. Moreover, it is feasible to send members prescription reminders utilizing IOT technologies. Companies all across the world are currently implementing and using this solution. For instance, CRF Health and Vodafone have worked together to give 550 individuals in 74 different

countries with a clinical trial registration system. In 74 nations throughout the world, this technology offers clinical trial operators and their patients a higher level of service (Gopal, 2019). 5-2-3- The development of an application in the areas of health, health, and body proportions is another use of the Internet of Things. The names of some of these applications and their uses are shown in Table 1.

**Table 1. Names of some of these applications and applications in the field of medical equipment**

<b>Application name</b>	<b>Function</b>
<b>MYfitnessPal</b>	Calorie counter, diet, exercise book
<b>RunKeeper</b>	Running and walking tracking
<b>Apps by Azumio</b>	Argus (tracking steps, calories, meals, sleep hours, heart rate, etc.)
<b>Nike+</b>	Running tracker (creating motivation to run by competing in running clubs)
<b>Map MYfitness</b>	Exercise tracking, cycling, and calorie counter
<b>Runtastic</b>	Track running, cycling, and fitness with GPS
<b>Endomondo</b>	Running, cycling, walking, and...
<b>My NetDairy</b>	Calorie and food tracker (with programming and analysis capabilities)
<b>iTriageHealth</b>	Finding a doctor, hospital, and...

These applications offer information on general health and body proportions, as well as guidelines in this area, in addition to allowing private users to track health data. The Internet of Things in treatment centers has a direct impact on their efficient operation, making it one of the most significant technical endeavors in the treatment sector to improve the performance of treatment centers like hospitals (Canchon, 2016). Heart, respiratory, and diabetes control patients' vital signs are continually recorded and stored at all times of the day and night to monitor their vital signs as well as their unique characteristics utilizing smart instruments with a communication system (website). A variety of sensors are shown in the picture below, along with their effectiveness. These sensors typically record data on variables including blood sugar, blood pressure, breaths per minute, and heart rate per minute (Qassemi, Safari, and Jokar, 2015).

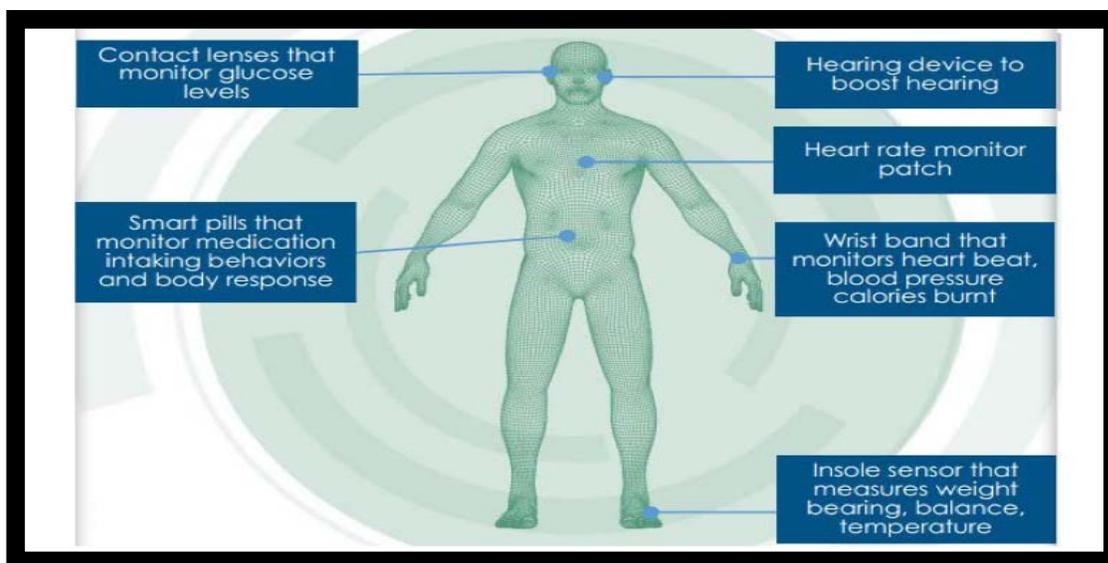


Figure2. *Clinical trials*

Similarly, remote services boost health intelligence in areas like health improvement and illness prevention by continually monitoring regular people's behaviors in accordance with set threshold levels. It is possible to offer services remotely using the Internet and the best tools in the fields of service delivery, emergency and first aid, education, and home health, diet and medication management, remote medicine and remote diagnostics, health social networks, etc. (Vaazi and Rezaei Rad, 2018).

In the area of drug usage, the Internet of Things can verify consumption. Small rice-grain-sized tiny sensors that can communicate with an external control device are included within the pills for this purpose. This makes it possible to guarantee the correct dosage and effectiveness of pills (Jahanbakhsh and Tavakoli, 2013).

Bluetooth-enabled toothbrushes used in dentistry may record a user's brushing habits with the aid of a clever mobile application. It may be used to check a person's brushing habits as personal information, and statistics can be given to the dentist (website). He employed tools like RFIDs, which are intended to assess environmental or hand- and body pollution, in the field of contamination control.

This technology will be used to improve health, productivity, security, business intelligence in hospitals and treatment facilities, patient care, aiding accident victims, and a wide

range of important information for people and businesses. The Internet of Things has expanded as a result of this (Kim, 2020). The use of IoT in the healthcare industry has reduced significant treatment costs, decreased global mortality rates from diabetes, hypertension, obesity, and smoking, decreased mortality rates due to hospital infections, improved treatment outcomes, improved disease management, improved medication management, decreased human error, and online services using non-referral medical services (Bodor, 2019). Despite the fact that the Internet of Things has significantly changed the medical industry and its equipment, numerous studies and research have been conducted to address the challenges in the field of technology complexity confidentiality, including standardization of the Internet of Things-related products and devices, application programs, continuous monitoring, technology transfer, the existence of new diseases and considering their future, as well as creating an information gap due to high sensitivity (website).

The security of personal medical data, which is kept and sent through linked devices, is the key issue with this technology. Although most businesses make an effort to store and encrypt sensitive data securely, they have no control over the security and safety of that data when it is sent across access points. The applications of the Internet of Things are grouped below according to the players involved in the medical equipment business and the field of treatment to learn more about the many uses of this technology:

**Table2. IoT applications in the field of health according to related players**

Group	Application
Patients	empowering and more effectively use medical services - Faster illness detection and treatment based on more precise data, with less interruption to patients' lives and lower cost - assisting a large patient population, including

	the elderly, to live independently for longer and in a better way
<b>Health service providers</b>	Enhancing patient care quickly, eliminating admission fees, and lessening the workload on staff will all help these organizations carry out their everyday activities more successfully.
<b>Pharmacists and contractual research organizations</b>	Gaining new pricing strategies, particularly by harmonizing the price of specific clinical measures, gaining more and better information from clinical trials, and improving supply chain and manufacturing process efficiency.
<b>Medical equipment manufacturers</b>	Creating a variety of medical gadgets that can link to the Internet of Things (such as glucose monitoring devices). Blood is needed for diabetes patients, and battery sensors are used to check the health of shock devices when they are needed.
<b>Drug stores</b>	Using smart devices to renew prescriptions, eliminating errors and delays, prompting patients to take their medications, and connecting smart pill boxes with doctor's prescriptions.
<b>Governments and industry bodies</b>	The application of large-scale data sets generated from the study of treatment outcomes, monitoring illness prevalence, and comprehension of population health macro-trends for making policy decisions.
<b>Insurance companies and insurance payers</b>	To provide new services and the potential to manage the business when exposed to risk, new amounts of information on patients and their health are being gathered.

A thorough description of the areas of application of the Internet of Things for smart health in the medical and health equipment industry has been published based on the study of the Internet of Things European Research Cluster (IERC).

Some applications are product-type ones, while others are service-type ones. The table below includes a list of Internet of Things applications for medical and health equipment.

**Table3. IoT applications in the field of medicine and health**

<b>Application</b>	<b>Descriptions</b>
<b>fall detection</b>	This application aims to assist the elderly and disabled in living independently by focusing on their needs.
<b>Monitoring the physical activities of the elderly</b>	It is possible to track a person's physiological status and physical activity by installing specialized sensors (especially for the elderly). In this instance, data may be gathered over time from these individuals and examined.
<b>Medical refrigerators (internal temperature control of protectors)</b>	Certain organic substances need to be stored in rooms with certain temperature requirements. The creation of the interaction of objects may easily be done through the Internet of Things.
<b>Caring for athletes</b>	This program is designed to monitor vital statistics for professional athletes, such as weight, blood pressure, sleep, and activity.
<b>Patients monitoring</b>	It is utilized for patient care in hospitals, in distant locations (particularly for the elderly), and at home.

<b>Management of chronic diseases</b>	Taking care of patients or people with chronic illnesses without having to be there in person. This technique decreases the number of hospital visits, which lowers costs, shortens stay times, and minimizes travel time.
<b>Ultraviolet rays</b>	Measuring UV radiation and warning individuals to stay out of specific places or to prevent UV exposure at particular times.
<b>Pollution control (hand hygiene)</b>	Environmental pollution, hand and body pollution, and other types of pollution can be recognized by attaching equipment like RFIDs intended to assess pollution.
<b>Sleep control</b>	Devices that connect to a person and recognize symptoms like heart rate, blood pressure, etc. while they are sleeping. These data may then be evaluated.
<b>Tooth health</b>	Bluetooth-enabled toothbrushes can be used with smartphone applications to capture brushing data, which may then be used to share statistics with the dentist or to monitor a person's brushing habits.

#### **4- Challenges of realizing the Internet of Things in the field of health:**

##### ***1-4- Examining the challenges from people's view:***

The worry of the users of this sector is one of the difficulties in implementing the Internet of Things in the field of health. Various studies on consumers' perceptions of the Internet of Things in the sphere of health have been conducted thus far. One of these studies, carried out by Park Associates in 2015, looked at consumers' top worries about health applications and the internet data they provide.

This study, which focused on Americans, looked at their issues and worries related to using health applications.

This study reveals that one of the American public's top worries about utilizing health applications is fear of non-confidentiality of personal information, rapid loss of interest in these tools, inadequate instruction from doctors on how to use the information, slow response times from healthcare professionals, the stupidity of information provided by applications, which occasionally results in users making mistakes, and generality of information provided by applications are just a few of the reasons why people may not use these tools (Miller, 2016).

##### ***2-4- Analyzing the challenges from the point of view of doctors:***

Considering a study performed by MedData Group in 2015, among the most important concerns of doctors in working with health applications are high cost, patients' resistance to change in their lifestyle, technological limitations, privacy concerns, and patients' resistance to new technologies. According to a 2015 IBM study, there are three main areas where the Internet of Things in the health sector is encountering significant challenges: aggregation, intelligence, and measurement and communication tools (ibid).

##### ***3-4- Examining the challenges from a technology perspective:***

The massive volume of data created on this platform will be one of the biggest obstacles to implementing the Internet of Things.

Big data refers to these data. Per person will generate around 1.7 gigabytes of fresh data each minute in 2030, according to predictions. It should go without saying that a substantial technology foundation will be needed to record, process, analyze, and transfer this information. The development of a wireless network suitable for the Internet of Things has additional difficulties. High range, information security, low power usage, high data transfer rate, transmission latency, portability or stability, dependability, and cohabitation are some of these difficulties. To handle the enormous amount of devices and communications in the Internet of Things, the aforementioned qualities in the new generation of communication networks must be sufficiently sophisticated (Mohammadian and Zarei, 2014).

##### **5- The future of the Internet of Things in the field of health and treatment:**

The introduction of components and chips based on the Internet of Things into the human body means that in the future, implants of smart chips based on IoT will be able to diagnose illnesses, treat pain, or even interpret brain impulses and transfer them to other bodily parts. This technology will make it feasible to treat persons with disabilities (Nazari, 2018).

##### **6- Conclusions and suggestions:**

The Internet of Things has the potential to impact everyone's lives as technology develops. The development of the Internet of Things has long since completely revolutionized the smart health industry. It will undoubtedly affect the field of medical

equipment manufacturing and how patients are treated. Its effects on technology-focused hospitals and treatment facilities have had a significant impact on disease prevention, quick disease diagnosis, and a decrease in global mortality. Doctors and other experts will find this topic important, but so will others without access to medical facilities. One may learn a lot about the Internet of Things technology and the cutting-edge uses of the Internet of Things in the field of health by studying this research.

Living in the information and communication age has made it necessary for human civilization, particularly the medical industry and its supporting cast, to employ new scientific phenomena. The usage of the Internet of Things system in hospitals strengthens it even more when you take into account the high per capita cost of health and treatment as well as the decrease in patients' mental health in addition to their physical ailment. Accordingly, the effectiveness of the medical equipment industry can be determined in terms of functional areas (growth rate, amount of services provided, customer satisfaction, and reduction of service costs), processes (speed and quality of service provision), and internal (employee satisfaction also affects the internal quality processes of the medical equipment industry to provide appropriate services and quality, creative, and innovative treatment staff). Thus, the usage of the Internet of Things given its components in the field of medical equipment and treatment (continuous collection and rounds of vital signs, continuous collection and rounds of chronic and common disease parameters, follow-up and monitoring, remote services, information management, sending intelligent content to the user, inter-organizational integration, environmental activity) will be strengthened, the organizational performance of this equipment will also be strongly applied and directed.

According to the cited sources, the Internet of Things is one of the greatest technological advances of our time. It can be used to receive, gather, store, prepare reports, and finally adopt the right strategies in the field of medical equipment and hospital patient care. The patient's mental and physical health, savings in cost, time, and space for patients and treatment staff are the main benefit (in the fastest time and without implementation obstacles). This will have a significant impact on the medical equipment industry's performance in the direction of productivity and excellence. However, the implementation of this technological system—which, along with conceptualization for better understanding—requires skilled professionals and competent medical personnel to apply the Internet of Things in the best way possible—is the crucial factor to take into account in this respect. One of the most significant demands of the people in society is the establishment of social justice, and it is hoped that by utilizing the Internet of Things in the nation's medical equipment, this

goal would be achieved. The environment's condition and the actions of the medical equipment will also be minimized and under control as a result of the current irregularities. Given its significance, it is anticipated that all medical facilities will be able to incorporate this kind of technological system into their entire operations and, using it as a foundation, direct society's health toward effectiveness and efficiency. Therefore, given the findings obtained in this research, equipping medical centers with smart devices equipped with Internet of Things with high security capabilities in order to collect and store vital signs and parameters of all chronic and common patients in any period of time; accurate measurement, monitoring and identification of patients at any place and time; providing basic medical services to patients with the necessary speed; setting up patients' meal plans; preparing reports with the ability to receive at any time possible the treatment status and history of patients, clarifying the process of symptoms - disease - diagnosis - treatment of patients objectively, preparing and collecting medical information of patients from other hospitals and medical centers as soon as possible and in any place to identify the treatment process and the disease of the patients, proper diagnosis and strengthening of medical and therapeutic performance, minimal reduction of hospital waste, preventing radiation and radio waves and maintaining environmental health for patients and the general public, holding effective training courses on information and communication technologies in the field of health and health, including the Internet of Things are offered online and periodically.

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