

Analysis of Challenges and Benefits of Internet of Things in Healthcare

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Abstract: *The research paper discusses various challenges related to Internet of Things implementation into the healthcare sector, for example data resource management, security, loss of privacy, access control, and stakeholder collaboration.*

In the future Internet of thing is going to be an integral part of the patient's diagnosis, treatment, recovery, and monitoring process.

It is estimated that a large number of objects will be connected to the Internet of thing network. All these devices will generate unstructured data; these data must be processed in a time-critical manner. Otherwise, it becomes inadequate for real-time monitoring and decision-making, which requires immense infrastructure, computation, networking, storage capacity, etc. For monitoring purposes, it is critical to process and deliver data in synchronization to the stakeholders like treating physician's panel, analytics platforms, healthcare providers, and insurance companies

Patients' data security is a another challenge for IoT healthcare system these data flow in the network without any encryption. Any malicious actor can access data and can cause severe consequences. Patient's data can be altered, and these corrupted data can be used to take the life and death decisions. Data can be corrupted at the origin or in the network. The concern is about how to trust the data received from sensors, which travel across the network.

Privacy is also of extreme importance in IoT healthcare system as the patients expect their information (medical or otherwise) to be confidential. Only necessary information that is required to provide the healthcare should be sent over the network. The government also plays an important role while dealing with the loss of privacy. A government may form laws to protect the sensitive information of citizens. Finally, IoT healthcare system is a collaboration between the health care industry and the IoT sector. All the stakeholders, especially the one who will make use of this system (e.g., nurses, patients, doctors), should receive a precise and professional training, and to a large extent the success of the IoT healthcare industry will be dependent on it

Keywords: Internet of Things

I. INTRODUCTION

Internet of Things is the networking of physical objects that contain electronics embedded within their architecture in order to communicate and sense interactions amongst each other or with respect to the external environment.

Internet of Things is referring to the interconnectedness of physical devices, such as appliances and vehicles, that are embedded with software, sensors, and connectivity which enables these objects to connect and exchange data. This technology allows for the collection and sharing of data from a vast network of devices in to more efficient and automated systems.

In the upcoming years, IoT-based technology will offer advanced levels of services and practically change the way people lead their daily lives. Advancements in medicine, power, gene therapies, agriculture, smart cities, and smart homes are just a few of the categorical examples where IoT is strongly established.

IOT is a system of interrelated things, computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers. And the ability to transfer the data over a network requiring human-to-human or human-to-computer interaction.

II. HISTORY OF INTERNET OF THING

The internet of thing has come a long way going from one or two machine in 1980 to billion in 2024. The innovation history of IoT from 1982 till 2024 given as below

1982 – Vending machine: The first glimpse of IoT emerged as a vending machine at Carnegie Mellon University was connected to the internet to report its inventory and status, paving the way for remote monitoring.

1990 – Toaster: Early IoT innovation saw a toaster connected to the internet, allowing users to control it remotely, foreshadowing the convenience of smart home devices.

1999 – IoT Coined (Kevin Ashton): Kevin Ashton coined the term “Internet of Things” to describe the interconnected network of devices communicating and sharing data, laying the foundation for a new era of connectivity.

2000 – LG Smart Fridge: The LG Smart Fridge marked a breakthrough, enabling users to check and manage refrigerator contents remotely, showcasing the potential of IoT in daily life.

2004 – Smart Watch: The advent of smartwatches introduced IoT to the wearable tech realm, offering fitness tracking and notifications on-the-go.

2007 – Smart iPhone: Apple’s iPhone became a game-changer, integrating IoT capabilities with apps that connected users to a myriad of services and devices, transforming smartphones into hubs.

2009 – Car Testing: IoT entered the automotive industry, enhancing vehicles with sensors for real-time diagnostics, performance monitoring, and remote testing.

2011 – Smart TV: The introduction of Smart TVs brought IoT to the living room, enabling internet connectivity for streaming, app usage, and interactive content.

2013 – Google Lens: Google Lens showcased IoT’s potential in image recognition, allowing smartphones to provide information about objects in the physical world.

2014 – Echo: Amazon’s Echo, equipped with the virtual assistant Alexa, demonstrated the power of voice-activated IoT, making smart homes more intuitive and responsive.

2015 – Tesla Autopilot: Tesla’s Autopilot system exemplified IoT in automobiles, introducing semi-autonomous driving capabilities through interconnected sensors and software.

2016-General Motors, Lyft, Tesla, and Uber are all testing self-driving cars. Unfortunately, the first massive IoT malware attack is also confirmed, with the Mirai botnet assaulting IoT devices with manufacturer-default logins, taking them over, and using them to DDoS popular websites.

2017-2019 - IoT development gets cheaper, easier, and more broadly-accepted, leading to small waves of innovation all over the industry. Self-driving cars continue to improve, blockchains and AI begin to be integrated into IoT platforms, and increased smartphone/broadband penetration continues to make IoT an attractive proposition for the future.

III. INTERNET OF THING IN HEALTHCARE

The Internet of Things (IoT) in healthcare also known as Internet of Medical Things or Connected health refers to the use of Internet of Things technologies in the field of medical. The Healthcare IoT market is defined by revenues generated specifically from components and services that enable connectivity and intelligence. These include hardware (like sensors, chips, and other IoT-specific components), platforms (like IoT platforms, security software), connectivity solutions (like cellular, LoRa, Sigfox), and services (like equipment/system integration and maintenance).

Healthcare industry has actively started to incorporate Internet of Things to improve the quality of healthcare services for the patient’s overall health. For example, Open Artificial Pancreas System measures the amount of glucose in a patient’s bloodstream and automatically delivers the required amount of insulin into the system .Another example is connected inhalers; it has a sensor attached to the inhaler and is connected to the app on the mobile phone, and it aids patients to self-manage their health condition better. From the above example it is clearly shows that IoT is going to be an essential part of the patient’s diagnosis, treatment, and recovery process

The global internet of things in healthcare market size accounted for USD 53.64 billion in 2024, grew to USD 65.03 billion in 2025 and is predicted to surpass around USD 368.06 billion by 2034, representing a healthy CAGR of 21.24%

between 2024 and 2034. The North America internet of things (IOT) in healthcare market size is calculated at USD 18.77 billion in 2024 and is expected to grow at a fastest CAGR of 21.40% during the forecast year. It exhibits IoT's potential in the healthcare sector. There are several advantages of implementation of Internet of thing in healthcare like fewer errors in data collection, faster diagnosis, efficient patient care, and better resource management in hospitals.

IV. HEALTHCARE INTERNET OF THING IN INDIA

The Internet of Things (IoT) is making significant inroads into the healthcare sector in India. Internet of Thing in healthcare involves connected medical devices, remote patient monitoring, and data analytics to improve patient care and outcomes.

With the increasing demand for telehealth and the need for remote healthcare solutions the Internet of thing in healthcare market in India is poised to play a vital role in providing accessible and efficient healthcare services

Drivers of the Market

The India Internet of Things (IoT) in healthcare market is experiencing substantial growth driven by several factors. The healthcare sector is recognizing the potential of IoT to enhance patient care, improve diagnostics, and streamline hospital operations. IoT devices, like wearables and remote monitoring systems, are becoming more prevalent, offering real-time health data and enabling telehealth services, especially in rural areas. The India government's focus on affordable and accessible healthcare is encouraging IoT adoption in the sector. Additionally, the COVID-19 pandemic highlighted the need for remote healthcare solutions, further boosting the demand for IoT in healthcare applications.

Challenges of the Market

Remote asset management in India confronts challenges associated with monitoring and maintaining assets distributed across diverse geographic locations. Ensuring real-time data access and security for remote assets can be complex. The need to integrate asset management solutions with existing business processes and systems is also a challenge.

The Healthcare IoT market in India is expected to witness a substantial increase in revenue, reaching ₹US\$2.42bn by 2025.

The healthcare IoT market is expected to show an annual growth rate (CAGR 2023-2028) of 17.8%, leading to a market volume of US\$289.2 billion by 2028.

This projection indicates a promising growth trajectory for the industry.

Furthermore, it is anticipated that the sector will experience a steady annual growth rate (CAGR 2025-2029) of 12.60%, culminating in a market volume of ₹US\$3.89bn by 2029.

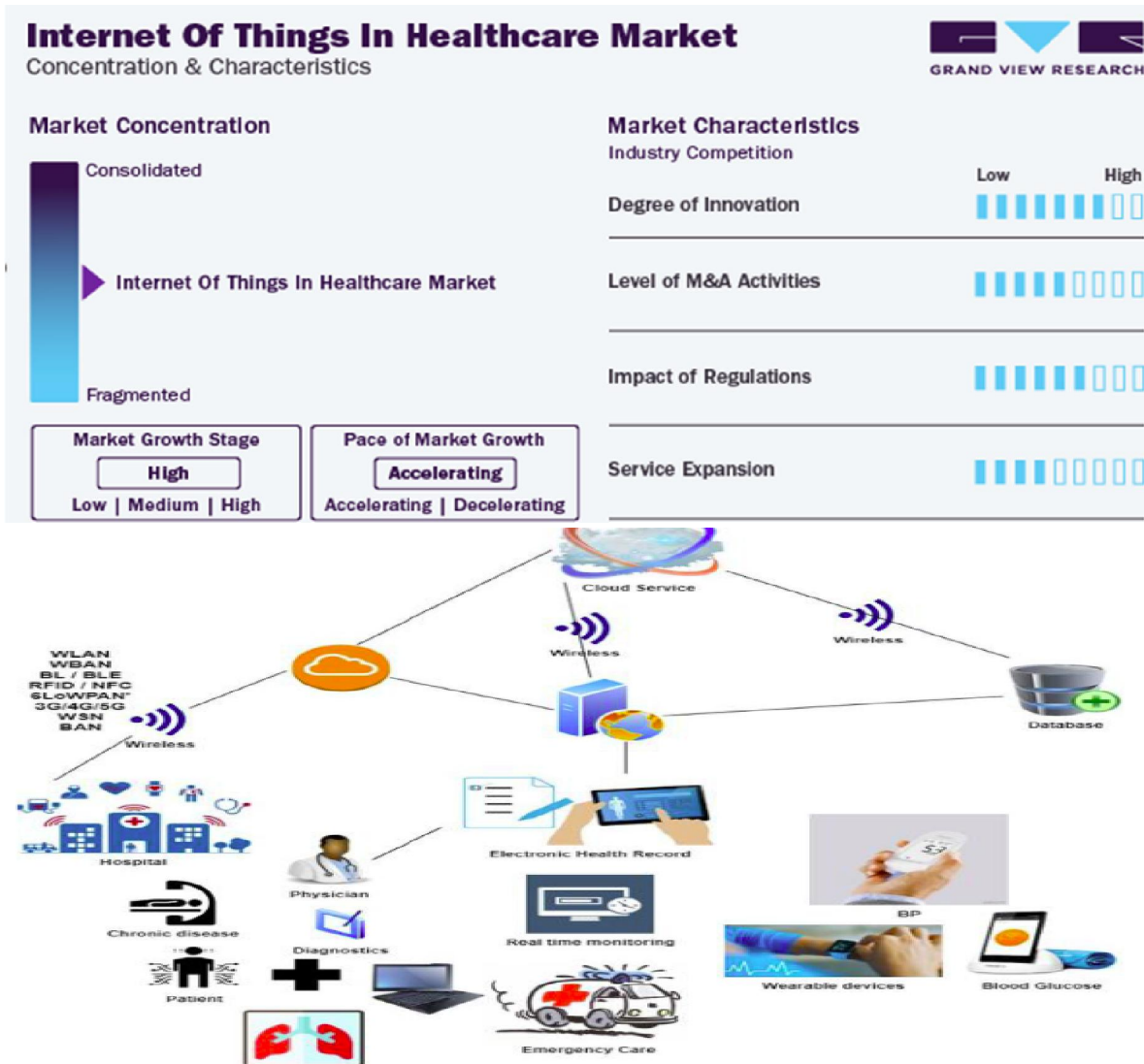
When comparing these figures on a global scale, it becomes evident that United States will dominate the Healthcare IoT market, generating a significant revenue of US\$33,040.00m in 2025. This highlights United States' position as a frontrunner in the industry, surpassing other countries in terms of market size and potential.

India is experiencing a surge in healthcare IoT adoption, with hospitals and clinics integrating smart devices to enhance patient monitoring and improve healthcare delivery. Some other key statistics on the current state of IoT in healthcare include:

- i. The services segment held a 59% revenue share in 2022.
- ii. The hospital segment has garnered a 35% revenue share in 2022.
- iii. Asia Pacific region is projected to grow at a CAGR of 18.50% from 2023 to 2032.

When comparing these figures on a global scale, it becomes evident that United States will dominate the Healthcare IoT market, generating a significant revenue of US\$33,040.00m in 2025. India is experiencing a surge in healthcare IoT adoption, with hospitals and clinics integrating smart devices to enhance patient monitoring and improve healthcare delivery. The healthcare industry is beginning to see a surge in the adoption of Internet of Things (IoT) technology. The rapid development of new innovative technology with various government-integrated facilities is driving market growth. Internet of thing and the related market are as below

Health care IoT [IT Services] Consumer IoT [Devices] Industrial IoT [Software] Automotive IoT [Public Cloud]



V. HOW INTERNET OF THING IS BENEFICIAL FOR HEALTH CARE

The Internet of Things has emerged as a ground-breaking technology that gathers vital body parameters from patients and monitors their pathological data through miniature wearable devices and ingestible sensors. It has a greater potential for improving people's health and supports a wide range of applications, from implantable medical devices to wireless body area networks and cloud-based analytics platforms.

Thus, IoT-based health care solutions can be used in many areas, including remote health monitoring, and treating chronic diseases, fitness programs, elderly treatment and pandemic circumstances. The IoT has changed the lives of many patients mainly the elderly, by allowing for constant tracking of their health conditions.

This has a considerable impact on individuals living alone and their families where a context-dependent alert mechanism sends signals to family members or health person on any disturbance or changes in persons routine activities, so they can take necessary precautionary measures. Based on the interaction and usage, different stakeholders are interacting with related IoT technologies in several ways.

VI. IMPORTANCE OF INTERNET OF THING IN HEALTHCARE

In healthcare, IoT-based healthcare systems collect a variety of patient data and get inputs from doctors and medical professionals. Continuous glucose monitoring for insulin pens is the best example of this.

All these devices can communicate with each other and take important actions that would provide timely help to save someone's life. After collecting the data, an IoT healthcare device would send this critical information to the cloud so that doctors can act upon it.

From this, we can say that the potential application of IoT in healthcare can improve a patient's health, healthcare employee productivity, and hospital workflow.

Here is the detailed workflow of IoT healthcare:

- i. A sensor collects data from a patient, doctor or nurse inputs data.
- ii. AI-driven algorithms like Machine Learning are used to analyse the collected data
- iii. The device decides whether to act or send the information to the cloud.

Doctors or health practitioners can make actionable and informed decisions based on the data provided by IoT healthcare solutions

VII. CONCLUSION

Internet of is going to be an integral part of the patient's diagnosis, treatment, and recovery process. IoT data collection mechanism coupled with predictive analytics will improve healthcare and reduce human errors. Internet of thing in healthcare has several challenges such as data handling, resource management, security, privacy, interoperability, stakeholder collaboration, and actual implementation. At present, security is the biggest barrier to the success of IoT. Considering the enormous number of devices generating huge unstructured data, data handling and resource management are also going to be a challenge in the near future.

The Internet of Things is becoming an emerging trend and has significant potential to replace other technologies, where researchers consider it as the future of the internet. It has given tremendous support and become the building blocks in the development of important cyber-physical systems and it is being severed in a variety of application domains, including healthcare

Interoperability between IoT devices and creating values through stakeholder tie-up will decide the success or failure of the IoT systems in healthcare industry.

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