



e-ISSN:2582-7219



# INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 11, November 2024



INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 7.521



6381 907 438



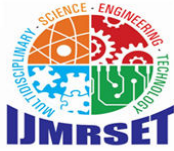
6381 907 438



ijmrset@gmail.com



www.ijmrset.com



## International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

# IoT in Healthcare: Applications & Challenges

Mrs. Deepika K S, Dhanushree P, Manmitha M

Assistant Professor, Department of Computer Science and Engineering, CIT, Gubbi, Tumakuru, Karnataka, India

U.G. Student, Department of Computer Science and Engineering, CIT, Gubbi, Tumakuru, Karnataka, India

U.G. Student, Department of Computer Science and Engineering, CIT, Gubbi, Tumakuru, Karnataka, India

**ABSTRACT:** The Internet of Things (IoT) has significantly advanced the healthcare sector by bringing forth revolutionary advancements in patient care, diagnostics, and healthcare delivery systems. From telemedicine and smart hospitals to remote patient monitoring, this review article examines the various uses of IoT in healthcare and medicine. IoT uses mobile devices, sensors, and networked systems to provide real-time health monitoring, remote consultations, and better prescription adherence. However, a number of significant barriers stand in the way of the widespread use of IoT in healthcare, including worries about privacy and data security, interoperability, regulatory compliance, scalability, and cost effect. This article offers suggestions for overcoming obstacles and seeing the future while demonstrating the apparent advantages of IoT setups through case studies and success stories. In order to improve patient outcomes, streamline healthcare delivery, and spur innovation in digital health, stakeholders in the healthcare ecosystem can fully utilize IoT.

**KEYWORDS:** IoT in healthcare, applications, challenges

## I. INTRODUCTION

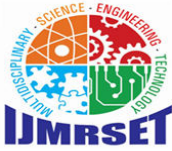
The combination of technology and healthcare ushered in a new era of innovation, with the Internet of Things (IoT) becoming a crucial component of advancement. In recent years, IoT has become a major trend in the healthcare industry, presenting previously unheard-of chances to transform patient care, diagnosis, and healthcare delivery systems. In the context of healthcare, the Internet of Things (IoT) refers to a network of linked systems, sensors, and gadgets that gather, share, and analyze vast volumes of data in real time. This connectivity allows doctors to provide telemedicine consultations, monitor patients' health remotely, streamline hospital operations, and improve patient care in general.

The importance of IoT in the healthcare industry is highlighted by its potential to solve persistent issues including patient engagement, cost management, and therapy access. Healthcare providers could leverage Internet of Things (IoT) technologies to increase the breadth of medical services they offer, increase the accuracy of evaluations, and give patients more control over their health.

The integration of IoT in healthcare is not without its obstacles, though. Many barriers, including those related to data security and privacy, interoperability, regulatory compliance, scalability constraints, and economic considerations, must be overcome in order to properly deploy IoT in healthcare.

The healthcare sector is using IoT technologies to enhance patient care and results while opening up new possibilities for remote monitoring, efficient healthcare delivery and tailored treatments. In addition to healthcare, the Internet of Things has an impact on agriculture, transportation, and industry. It has the power to totally change the way we live. Millions, if not trillions, of IoT devices currently generate enormous volumes of data through communications for various purposes. The processing and analysis of these enormous amounts of data depend on the cloud. We require cloud assistance to manage and evaluate the data. Cloud computing has made it possible for us to rent infrastructure, storage, and machines.

Mobile apps facilitate information exchange and self-management, while private messaging platforms promote communication between medical staff and patients.



## International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Devices in the Internet of Things transmit data effortlessly. Training and instruction are necessary to guarantee that consumers can utilize these technologies without feeling uneasy. Through the utilization of these services, people actively participate in their healthcare, which fosters improved communication and engagement and improves health outcomes.

The Internet of Things can help mechanize hospital infrastructure, increasing energy efficiency and improving patient and worker safety.

### II. APPLICATION OF IOT IN MEDICINE AND HEALTHCARE

#### A. Remote patient monitoring:

Wearable sensors and Internet of Things devices allow for the remote monitoring of health parameters, such as blood pressure and heart rate. This enables medical professionals to monitor patients' health conditions. Real-time patient status monitoring, prompt action when needed, and individualized treatment outside of conventional clinical settings are all included. One of the most common uses of IoT in healthcare systems is remote patient monitoring. One such example is the use of IoT devices to track chronic illnesses like diabetes or heart problems. Patients can give medical professionals real-time data by using wearable technology, such as glucose or heart rate monitor. A continuous glucose monitor (CGM), such as those made by Abbott's FreeStyle Libre or Dexcom, is one tool that people with diabetes can use to track their blood glucose levels. These gadgets transmit data to an app or a physician's office, enabling quick adjustments to treatment.

#### B. Telehealth and Telemedicine:

Through telemedicine services and consultations, patients can now interact with medical specialists remotely using smartphones or tablets thanks to the Internet of Things. Telemedicine platforms make healthcare services more accessible and less reliant on in-person visits by combining IoT devices with video conferencing, remote testing, and medical data exchange.

#### C. Prescription Adherence:

Internet of Things-enabled smart pill dispensers and prescribing systems assist patients in following their doctor's suggested dosage schedules. When a patient misses a dose or deviates from their treatment plan, these devices notify doctors or caregivers, track healthcare utilization, and remind patients to take their medications on time.

#### D. Health and Wellness Tracking:

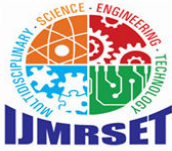
People can use Internet of Things devices and smartphone apps to monitor their fitness regimen, sleep habits, food consumption, and general wellness metrics. By receiving insights into their lifestyle choices through the collection and analysis of data from wearable fitness trackers, smart scales, and health monitoring applications, users may make well-informed decisions that enhance their wellness.

#### E. Intelligent Healthcare Institutions and Hospitals:

Hospital infrastructure and medical equipment have incorporated IoT technology to improve patient care, expedite workflows, and increase operational efficiency. Smart hospitals use Internet of Things (IoT) technologies to enhance operations and enhance patient care. Ensure that the appropriate resources are accessible when required. For instance, Houston Methodist Hospital uses RFID (Radio Frequency Identification) technology to monitor medical equipment. In order to keep patients and equipment in optimal conditions, IoT sensors also monitor external factors like humidity and temperature. Smart hospital systems track and manage hospital beds, supplies, and equipment in real-time, allowing for prompt resource allocation and interventions.

#### F. Healthcare prevention and predictive analytics:

Devices with Internet of Things capabilities collect vast amounts of patient data. To find patterns, trends, and predictors of future health outcomes, the collected data may be analyzed without the aid of machine learning algorithms and sophisticated analytics. Healthcare providers can use predictive analytics to better manage population health, foresee and prevent unfavorable health outcomes, and customize treatment plans.



## International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

### G. Chronic Disease Management:

Internet of Things (IoT) devices help manage long-term disorders including diabetes, hypertension, and respiratory illnesses by consistently monitoring patients' health and offering tailored therapies. Connected devices such as insulin pumps, continuous glucose monitors, and inhalers assist patients better control their diseases and reduce their risk of complications.

### H. IoT in Senior Care:

IoT devices are crucial when it comes to helping senior citizens who would rather age in place. The US case of GrandCare Systems serves as an illustration of this. Seniors can be remotely monitored by caregivers without the use of GrandCare's Internet of Things (IoT) gadget suite, which includes motion detectors and smart locks.

### I. Connected Medical Machinery:

Connected Medical Equipment: The Internet of Things (IoT) enables doctors to use a variety of medical equipment for analysis. An insulin pump and a glucose monitor, for instance, can talk to each other and automatically modify insulin dosages based on blood sugar levels. With this level of automation, patient outcomes are improved while the possibility of human error is decreased.



Fig . 1 IoT for healthcare

## III. CHALLENGES OF IMPLEMENTING IOT IN HEALTHCARE

### A. Data Security and Privacy Issues:

IoT devices run the risk of receiving and processing private patient health information, which could lead to security flaws and privacy violations. It is crucial to employ robust encryption, authentication systems, and data safeguards to protect patient information from cyber threats and unlawful access.

### B. Interoperability Issues:

The taxonomy analysis of the sequencing data was performed using the pre-trained Naïve Bayes classifier in the QIIME 2 classifier tool. The Greengenes 99% OTUs (Operational Taxonomic Units) were used to train the classifier. The QIIME taxonomy barplot tool was then used to display the taxonomic makeup in bar plots. ASVs classified as "unassigned" were those whose taxonomic levels could not be ascertained.

### C. Regulatory Compliance:

Regulations governing the healthcare industry establish strict guidelines for gathering, storing, and discarding patient health data. IoT technology in healthcare settings necessitates a close attention to data security and privacy requirements in order to ensure regulatory compliance.



## International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

**D. Scalability and Infrastructure:** Establishing IoT solutions in the healthcare industry necessitates a robust infrastructure, including a fast internet connection, cloud storage, and network capacity, in order to support the diverse array of networked devices and manage the volume of data generated. To accommodate growing patient populations and healthcare institutions, larger IoT implementations require careful planning and infrastructure updates.

### E. Implications for Cost:

Software upgrades, ongoing maintenance, and support services raise the total cost of ownership, necessitating careful resource allocation and budgeting.

**F. User Acceptance and Training:** Medical professionals, patients, and caregivers may find it difficult to accept and use IoT devices and applications due to technological inexperience, usability problems, and worries about accuracy and dependability. In order to successfully integrate IoT technology into clinical practice and enhance user adoption, both patients and healthcare providers need to be given thorough training and support services.6.

### G. Considerations for Ethics and the Law:

To address the ethical concerns surrounding the use of IoT in healthcare, such as data ownership, authorization, and patient autonomy, careful thought and commitment to ethical guidelines and principles are needed. fostering trust and upholding moral principles in the provision of healthcare.

## IV. FUTURE PATHWAYS AND PROPOSALS FOR NETWORK WITH THINGS IN HEALTHCARE

**A. Interoperability Standards:** IoT platforms and devices must have interoperability standards created in order for information to flow freely and integrate with healthcare systems. Interoperability frameworks that enable data exchange and interoperability across various systems must be developed and implemented cooperatively by industry competitors, standards bodies, and regulators.

**B. Improving Privacy and Security of Data:** in order to safeguard confidential patient data. Improving data security and privacy protocols for IoT devices and healthcare systems is crucial. Ensuring patient privacy in IoT-enabled healthcare scenarios may be made easier by implementing strong encryption, authentication procedures, and access controls.

**C. Regulation and Compliance:** Stricter regulations and compliance criteria for IoT in healthcare are necessary to guarantee adherence to cybersecurity, privacy, and data protection norms. The industry's stakeholders should work with authorities to develop policies and guidelines that handle particular risks and difficulties related to IoT construction in healthcare situations.

**D. Research and Development :** Expenditure must be sustained in order to promote innovation and advancement in IoT technology for healthcare applications. Collaborative research, technology pilots, and proof-of-concept initiatives funded by the 13th financing might hasten the creation and application of Web of Everything solutions that tackle significant issues in healthcare and enhance patient outcomes.

**E. Integration with Analytics and Artificial Intelligence:** New avenues for population health management, customized medicine, and predictive analytics can be investigated by combining IoT data with smart analytics tools and AI. AI-powered methods for analyzing Web of Everything data, seeing patterns, and extracting relevant information that influences physician judgment and enhances patient outcomes should be investigated by hospitals.

## V. IMPACT OF IOT ON PATIENT OUTCOMES

**A. Early Detection and Prevention:** Because IoT devices have the ability to continuously monitor vital signs, medical personnel may be able to identify possible health problems early on. This early discovery could lead to faster therapies and better results. Wearable medical devices that monitor vital signs like heart rate, blood pressure, blood sugar, or other parameters may notify patients and medical professionals of potential risks, allowing for timely treatment.



## International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

**B. Treatment with personalized care:** IoT makes it easier to gather medical data, which enables tailored medication. By using this data, treatment regimens that are customized to each patient's unique needs can be created, increasing the efficacy of healthcare. IoT allows insulin pumps, for instance, to automatically modify insulin dosage depending on real-time glucose readings, improving diabetes treatment.

**C. Better chronic illness management:** IoT devices can significantly enhance the management of long-term medical diseases like diabetes, asthma, and high cholesterol. Doctors may keep an eye on their patients' health, make sure they're taking their medications as directed, and notify them of any problems with remote monitoring. Better disease management and fewer hospitalizations are the results of this ongoing assistance.

**D. Reduced readmissions:** The rate of readmission can be decreased by healthcare providers keeping a careful eye on patients following discharge. This enables them to identify early signals of complications. For example, IoT devices can monitor newly operated patients' vital signs and notify medical professionals of any changes or other possible issues.

### VI. IMPACT OF IOT ON HEALTHCARE EFFICIENCY

**A. Streamlined Workflow and Resource Management:** IoT helps to enhance hospital operations by streamlining resource management. Hospitals can use RFID (Radio Frequency Identification) tags on inventory and equipment to keep an eye on assets, stop loss, and ensure resources are where they're needed. Furthermore, this technology helps enhance patient flow and reduce wait times.

**B. Lower Operational expenses:**

By eliminating the need for manual labor in tasks like inventory management and equipment tracking, the Internet of Things (IoT) lowers operational expenses. Furthermore, IoT-enabled predictive maintenance for medical devices prolongs the life of costly equipment and reduces downtime. In general, there are differences in the alpha diversity indices among the three sites. More diversified bacteria may be able to survive and proliferate in the environment if the index value is greater.

**C. Enhanced Collaboration and Communication:**

Physicians can easily communicate with one another thanks to the Internet of Things. Connected medical devices allow multiple specialists to collaborate on patient treatment, and they can exchange data across platforms. In addition to reducing the possibility of misunderstanding, this integration offers a more comprehensive approach to treatment.

**D. Telehealth and remote healthcare**

It is possible to identify patterns and trends by analyzing the vast volumes of data generated by the Internet of Things. Healthcare organizations can utilize this information to better plan treatment, forecast patient outcomes, and make more educated decisions. In operational domains such as staff and resource allocation, analytics can also be utilized to increase overall efficiency.

### VII. IOT IMPLEMENTATION IN HEALTHCARE SETTINGS: ETHICAL ISSUES AND LEGAL REPERCUSSIONS

**A. Taking Ethics into Account**

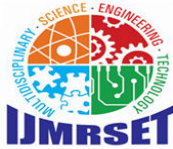
1) Privacy and Data protection: There are worries over the protection of personal information since sensitive patient data may be collected.

Retaining public confidence in healthcare systems requires data security and patient privacy.

2) It is essential to have patients' informed consent before gathering and sharing their data. Patients must understand precisely how, by whom, and why their information will be used.

**B. Autonomy and Control:**

There are worries regarding patient autonomy over their data and the decisions made using it, even though (IoT) gadgets may enable patients to actively focus.



## International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

### C. Legal Consequences

- 1) Regulatory Compliance: Current laws like the Health Insurance Portability and Accountability Act must be followed by healthcare IoT systems in order to protect patient data security and privacy.
- 2) Data Minimization: It is crucial to put data minimization laws into place to guarantee that only pertinent data is gathered and lower the possibility of data breaches and misuse.
- 3) Security by Design: From the outset of IoT device design, businesses should have prioritized security measures to reduce risks and safeguard patient data.

### VIII. CONCLUSION

Through previously unheard-of opportunities to increase access to care, enhance patient outcomes, and streamline operational procedures, the application of Internet of Things (IoT) technology in healthcare and medicine is revolutionizing the way healthcare is delivered. IoT enables physicians and nurses to deliver more effective, efficient, and individualized treatment through proactive healthcare management, telemedicine, tailored medicine, and remote patient monitoring. Although the Internet of Things has many benefits, there are drawbacks as well. It is necessary to overcome significant challenges such data security regulations, compliance interoperability issues, needs, scalability considerations, and cost implications in order to fully realize the potential of IoT in healthcare settings. Additionally, ethical and legal concerns must be addressed, user acceptability must be guaranteed, and patient privacy must be protected when using IoT in healthcare. As we monitor these potential risks and difficulties, cooperation between health care stakeholders, technology developers, regulatory bodies, and patients is essential. Through the revolutionary potential of IoT technology, we can enhance population health outcomes, reduce healthcare inequities, and create a more equitable and sustainable healthcare ecosystem while promoting a culture of innovation, research, and teamwork. In conclusion, the Web of Things has the potential to revolutionize the way healthcare is delivered, empower people and shift the entire commercial landscape. Through innovation, best practices, and patient-centered care, we can fully employ IoT technology to build a healthier future for people and communities around the world.

### REFERENCES

- [1] Mkwashi A, Brass I. White Paper: The Prospects for Standards and Regulation of Medical Devices A White Paper The Future of Medical Device Standards and Regulation: Addressing Important Issues for Intelligent, Connected Medical Devices BSI in collaboration with PETRAS The Future of Medical Device Regulation and Standards: A White Paper. Zenodo 7054049 doi:10.5281
- [2]. The needs, difficulties, and current methods for data security and privacy with regard to precision health data. OI: 10.1016/j.compbio.2020.104130 24, 2020, published online in August.
- [3]. Optimization of Quality of Service in the Internet of Medical Things for Sustainable Management, Gautam A, Mahajan R, Zafar S. Research in Systems, Control and Decision, Vol. 311. Deutschland GmbH, Springer Science and Business Media, 2021:163-179. 8.10 doi:10.1007/978-3-030-55833
- [4] Mankodiya K, Chang V, Farahani B, Firouzi F, Badaroglu M, and Constant N. IoT EHealth Driven by Fog: Opportunities and Difficulties in Medicine and Healthcare.; 2017. <https://www.elsevier.com/open-access/userlicense/1.0/Mohanty, S., Mohapatra>
- [5]. IoT-Based Smart Healthcare: A Method for Pervasive Healthcare Management. In: Using Big Data Analytics to Manage Healthcare Intelligently. 2019:175–196; Elsevier; doi:10.1016/B978-0-12-818146-1.00007-6
- [6] Ray PP, De D, and Dash D. Internet of Things edge computing: An overview, case study on e-healthcare, and future directions. 2019;140:1-22. Journal of Network and Computer Applications, doi:10.1016/j.jnca.2019.05.005
- [7] S. Zakerbasali and S. M. Ayyoubzadeh (2022). A comprehensive analysis of the ethical concerns surrounding the Internet of Things and healthcare systems. 5(6) of Health Science Reports. The article <https://doi.org/10.1002/hsr2.863>
- [8] Pandey P, Kumar U, Pandey SC. Internet of Things Security Concerns in the Healthcare Industry: An Analytical Perspective. 2020:307-329. The doi is 10.1 007/978-981-15-1100-4\_15.
- [9] S. Zakerbasali and S. M. Ayyoubzadeh (2022). A comprehensive analysis of the ethical concerns surrounding the Internet of Things and healthcare systems. 5(6) of Health Science Reports. The article <https://doi.org/10.1002/hsr2.863>
- [10] Sita P, Reddi S, Murty R, Pericherla SS, and Naresh VS. The architecture, applications, difficulties, and solutions of the Internet of Things in healthcare. 2020; Vol. 6.



## International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

- [11] Garg J, Ajamu GJ, Awotunde JB, Folorunso SO, and Ajagbe SA. AiIoMT: System-Enabled Artificial Intelligence for Improved Smart Healthcare Systems Based on IoMT. In: Critical Internet of Medical Things Machine Learning: Use Cases and Applications. International Publishing, Springer, 2022:229–254. Reference: 10.1007/978-3-030 80928-7\_10
- [12] Farooq A, Liaqat RM, Joyia GJ, and Rehman S. Applications, advantages, and upcoming difficulties of the Internet of Medical Things (IOMT) in the healthcare industry. 240–247 in Journal of Communications, 12(4), 2017. doi:10.12720/jcm.12.4.240-247
- [13] Kaur A, Sharma S, Shabaz M, Dhiman G, Ratta P. Applications, Difficulties, and Prospects for the Future of Blockchain and IoT in the Healthcare and Medical Sector. 2021;2021; doi:10.1155/2021/7608296;
- [14] Moon, A. H., Lone, S. A., Mushtaq, S., Nissar, G., and Khan, R. A. (2024). An overview of IoT in healthcare that covers services, applications, important technology, security issues, and new developments. Tools and Applications for Multimedia. s11042-024-18580-7 <https://doi.org/10.1007> Li, C., Zhang, Y., Wang, J., and Wang, S.
- [15] (2024). An analysis of IoT applications in medical fields. The field of neurological computing <https://doi.org/10.1016/j.neucom.2023.127017> 565 [page].
- [16] Kumar, M.; Verma, S.; Kumar, A.; et al. (2023). Internet of Things (H-IoT) in Healthcare: Present Trends, Potential Future Uses, Difficulties, and Security Concerns. Electronics, 12(9), Switzerland. Electronics 12092050 (<https://doi.org/10.3390>)
- [17] In 2024, Parihar, A., Thakkar, A., Prajapati, J. B., Prajapati, B. G., Trambadiya, B., and Engineer, P. Applications, security issues, and privacy issues with the Internet of Things in healthcare. Intelligent Pharmacy, 1 (1). j.ipha.2024.01.003 <https://doi.org/10.1016>
- [18] Ibtisum, S., Hossain, S. M. S., Podder, P., & Rahman, S. M. A. (2023). Volume 185, pages 1–7, provides a brief overview of the advancements and difficulties of IoT in healthcare. in Proceedings of Materials Today. j.matpr.2023.02.062 <https://doi.org/10.1016>





INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | [ijmrset@gmail.com](mailto:ijmrset@gmail.com) |

[www.ijmrset.com](http://www.ijmrset.com)