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RESEARCH ARTICLE

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COMPARATIVE ANALYSIS OF IOT APPLICATIONS IN HEALTHCARE

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Manuscript Info**Abstract**

Transformative changes in healthcare is due to the fast progression of the Internet of Things (IoT), which empowers new replicas of patient care, operational efficiency, and medical data management. Comparative analysis of IoT applications in healthcare, synthesizing recent literature and practical implementations is done in this research paper. Remote patient monitoring, wearable health devices, smart hospital infrastructure, and IoT-enabled medical equipment are the key areas which are to be discussed in this research paper. In this highpoint are how IoT-driven solutions ease real-time health monitoring, early detection of anomalies, and adapted treatment, which leads to the improvement of patient outcome and reduces the cost of healthcare. IOT technologies also enhances the operations done in hospitals through asset tracking, environmental monitoring, and automated workflows, contributing to streamlined management and infection control. In spite of these assistances there are various challenges such as data security, interoperability, sensor accuracy, and the need for standardized protocols. This comparative review offers the complete prospective of benefits and limitations of IOT applications in healthcare on the current state contributing understandings for researchers, practitioners, and policymakers aiming to harness IoT for improved health services.

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Introduction:-

In the Internet of Things (IoT), the healthcare industry is experiencing a consequential transformation due to advancements in digital technologies. Without direct human interference, IoT refers to a network of interconnected devices that collect, transmit, and analyze data. In healthcare, IoT promote the incorporation of physical devices, software applications, and data analytics systems to empower smarter [3], faster, and more efficient medical care. This technological evolution is determined by increasing demands for real-time health monitoring, the growing burden on healthcare systems and the need for efficient care delivery caused by aging populations, chronic diseases, and limited resources. The integration of IoT in healthcare had given rise to the development of a variety of advanced applications. These include remote patient monitoring systems, which allow doctors to track patients' health readings from a distance; wearable fitness and medical devices, which provide Ongoing Health-related findings; smart hospital infrastructure, which improves workflow and resource utilization; and connected medical equipment, which ensures accurate Examination and timely treatment. To improve patient safety and clinical outcome[4], these applications allow healthcare professionals to make

evidence-based decisions, personalize treatment plans, and respond more quickly to emergencies. IoT's impact beyond patient care also reaches operational management. Automated drug dispensers, asset tracking systems, and environmental monitoring devices help reduce human error, optimizing hospital efficiency, and cutting operational costs. Additionally, IoT supports preventive care by analyzing trends in patient data to detect potential health risks before they become critical. IOT offers great benefits but also presents several challenges.

To ensure the safe and ethical implementation of these technologies, issues such as data privacy, cybersecurity, regulatory compliance, and system interoperability must be carefully addressed. To fully realize the benefits of IoT in diverse healthcare settings, there is a growing need for standardization in data formats, communication protocols, and integration methods. This paper aims to provide a comparative analysis of key IoT application categories in healthcare. IOT also brings challenges such as system security and data privacy that needs to overcome to get better advantage of IOT. It will evaluate their core functionalities, advantages, limitations, and implementation strategies. By examining these applications side by side, this research aims to provide insights into how IoT is reshaping the healthcare landscape, and what steps are necessary for sustainable, scalable, and secure adoption.

Literature Review

Distinct technological frameworks, benefits, and challenges across different domains are used in a comparative analysis of IoT[1] applications in healthcare. In today's era of remote patient monitoring, technologies such as pulse oximeters and cloud-based analytics are widely used, due to which significant benefits are offered which reduces the need for hospital visits and enabling proactive patient care. However, this causes challenges related to data security and scalability, as the sensitive nature of health data demands robust protection and leads to the expanding of the patient populations.

Now a days the digital electronic wearable devices such as smart watches are commonly uses heart rate sensors and mobile applications, allowing the patients to actively monitor their health management and facilitate preventive care[2]. The main advantages of wearable's are their ability to engage users and provide continuous health insights. Nevertheless, these devices often face trade-offs between measurement accuracy and user convenience, and issues such as limited battery life can hinder their effectiveness in long-term monitoring.

Bluetooth-enabled pacemakers and insulin pumps are the medical implants which determine the amalgamation of IoT in adapted medicine. Based on real-time physiological data are automated using these devices, which greatly [7]enhance care for chronic conditions treatment adjustments. Some challenges are also observed such as power consumption constraints and heightened cyber security risks, as unauthorized access could have critical penalties for patient safety.

Smart hospital infrastructure leverages technologies like RFID tags and IoT-enabled HVAC systems to streamline operations. Improved operational efficiency and substantial cost savings, as automated asset tracking and environmental controls reduce waste and enhance patient comfort are the benefits in this era[8]. However, interoperability issues and significant upfront investment requirements complicate the integration of IoT into existing hospital systems[5].

Research Methodology:-

To understand the topic, both qualitative and quantitative approach can be used to gather information and gain in depth knowledge of the topic. Qualitative research method includes the deep understanding of how IOT enabled healthcare system influence individuals, organizations, and society as a whole [6]. Direct observations help to understand the implementation of IOT technology and use in the healthcare environment. These methods also include text analysis of appropriate articles, reports and documents enable to understand practical and theoretical views concerning the integration of IOT in healthcare.

On the other hand, surveys, experiments, and secondary data analysis, Quantitative research measure variables related to IoT penetration in healthcare.

The advantages of quantitative research methods are its ability to provide strong empirical evidence related to the penetration and effects of IoT in healthcare, as well as allowing generalization of results to larger populations

IoT in healthcare form a connected healthcare environment by combining sensors, devices, information systems, and infrastructure to form a connected healthcare environment [9].

This enables users and medical devices to communicate directly, gather live health data and patient monitoring effectively. The goals of IOT in healthcare are Better Patient Monitoring, Chronic Disease Management, Telemedicine, Drug Development and Clinical Research, Healthcare Infrastructure Management. Sensors are used to calculate and handles the proposed data These are the foundation of IOT devices [10].When IOT is used in healthcare it offers different applications and many benefits and opportunities that improve medical services and patient monitoring, Wearable Devices, Connected Medical Devices, Smart Hospitals and Health Infrastructure, Telemedicine and Remote Consultation, Household Health. IoT has revolutionized personal health monitoring such as smart watches, activity tracking devices, and other health sensors, enabling continuous real-time tracking of vital health parameters through internet-connected devices.

Applications for the IoT Healthcare System**Telemart**

Telemart is helpful in the IoT as it avoids the challenging task to maintain a 6-ft distance in a supermarket, for example, during COVID-19. By providing a QR code for the store entrance to the users and after shopping, the money will be debited from the user's account[12]. Now the customer can pay without waiting in line for the counter without compromising social distancing requirements.

Nexleaf Analytics

This application is extremely valuable in emerging countries for both food preparation and safeguarding vaccines. These vaccines are placed in healthcare clinics to be continuously monitored. This system can measure patient data and send it to the cloud and server.

Wearable Devices

These devices monitor the health of patient wearing it on the body, such as smart bracelets, watches, skin patches, or smart clothing. They are employed to monitor oxygen level in the blood, pulse rate, fitness activity[11] and rest behaviour. Potential advantage includes the early disease detection, stress management, promotes physical activity.

Connected Medical Devices

These devices are integrated with the internet such as a connected insulin pump or digital ECG device. It provides health information directly to doctors or electronic health record (EHR) platforms [13]. This can enhance tracking the critical situations and facilitate quicker diagnoses.

Advanced Metering Infrastructure (AMI)

Smart grids are required to deliver continuous power supply to hospitals, clinics and other healthcare infrastructure. To monitor electricity consumption and distribution, Smart grids consist of sensors and transducers used and AMI handling this function. The AMI smart meters are connected with the internet through the IoT [14]. It is communicated to the main server of the electricity providers, after the meter reading is collected. The use of this application played a vital role in the safety of both the workers and the customers by minimizing direct interaction.

Personal health monitoring

IoT has transformed how we track personal health, individuals can actively monitor their health parameters in real time with smart watches, activity-tracking devices, and other health sensors. For example, Smart watches, are fitted with pulse sensors that constantly check the user's heart rate[15]. The valuable insights of data that are provided throughout the day, support user in managing their health conditions and get early warning if something is abnormal.

IoT is just starting to be used in healthcare but it possesses significant capability to enhance and personalized patient care.

Further Personalization in Healthcare

As IoT device collect more data, we can expect more personalized healthcare tailored to each individual because of increasing volume of data acquired[16]. Advance algorithms can be employed to analyse constant health data and offer highly accurate recommendations.

Development of Smarter IoT Devices Observe advancements in the creation of smarter and more cohesive IoT technologies. Such as medical gadgets that simultaneously measure several health parameters together and provide holistic recommendations based on recorded information.

The adoption of IoT in the field of personal health care comes with implementation concerns. Among the primary challenges are.

Concerns over Data Privacy and Security - As IoT devices collect large amounts of individual health data issues related to data privacy and protection are notable. Healthcare providers and IoT manufacturers must ensure to implement robust and transparent security measures to protect individual medical data.

Quality of Service – Quality of service is crucial in healthcare system in terms of reliability, effectiveness and high service[17]. Reliability in term of timely response. Standard of service should not be compromised primarily in healthcare because lack of attention can put a life at risk.

Implementation -To build smart communities, millions of affordable, energy-efficient sensors and devices are needed it is difficult to manage, implement and maintain such a vast and sophisticated infrastructure. Another major challenge is the price of device used for communication, operation, and infrastructure.

Integration and Standardization—Combining data from various devices is a key difficulty in the implementation of IoT in healthcare[18]. Consistent techniques for collecting, storing, and transmitting health data play a vital role in achieving seamless interoperability and avoiding isolated data systems.

E-Management - In the coming years, this area will face most of the challenges due to the transition of the traditional healthcare system to an IoT-based healthcare system. In the years ahead, this field will encounter numerous challenges, as the healthcare system evolves from a traditional to an IoT-based approach. As millions of sensors and devices in healthcare will be introduced in the future. Accordingly, service providers must ensure the management of technical faults, system setup, dependability, security, and efficiency to benefit users and healthcare operations.

Conclusion:-

Based on the results and discussion above it can be concluded that, implementation of healthcare brings about a transformative shift from outdated healthcare to advanced, data-oriented technologies. Although the use of wearable technologies, advanced infrastructure, networked medical instruments, and continuous patient monitoring, IoT has significantly advanced healthcare delivery, patient safety and operational performance. However, this transformation comes with critical challenges like data privacy security, scaling infrastructure, and cross-system operability. Upcoming research and financial support should concentrate on developing secure, economical and budget friendly and user centered technology for globally accessible smart healthcare.

References:-

- [1] Ding, B. (2018). Pharma Industry 4.0: Literature review and research opportunities in sustainable pharmaceutical supply chains. *Process Safety and Environmental Protection*, 119, 115-130.
- [2] Mohammed, M., Desyansah, S., Al-Zubaidi, S., & Yusuf, E. (2020). An internet of things-based smart homes and healthcare monitoring and management system. Paper presented at the *Journal of physics: conference series*.
- [3] Bhuiyan, M. N., Rahman, M. M., Billah, M. M., & Saha, D. (2021). Internet of things (IoT): A review of its enabling technologies in healthcare applications, standards protocols, security, and market opportunities. *IEEE Internet of Things Journal*, 8(13), 10474-10498.
- [4] Aceto, G., Persico, V., & Pescapé, A. (2018). The role of Information and Communication Technologies in healthcare: taxonomies, perspectives, and challenges. *Journal of Network and Computer Applications*, 107, 125-154.
- [5] Rathi V.K., Rajput N.K., Mishra S., Grover B.A., Tiwari P., Jaiswal A.K., Hossain M.S. An edge AI-enabled IoT healthcare monitoring system for smart cities. *Comput. Electr. Eng.* 2021;96:107524. doi: 10.1016/j.compeleceng.2021.107524.
- [6] Bhatia H., Panda S.N., Nagpal D. Internet of Things and its Applications in Healthcare—A Survey; Proceedings of the 2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO); Noida, India. 4–5 June 2020; pp. 305–310.
- [7] El Zouka H.A., Hosni M.M. Secure IoT communications for smart healthcare monitoring system. *Internet Things*. 2021;13:100036. doi: 10.1016/j.iot.2019.01.003.
- [8] Bhuiyan M.N., Rahman M.M., Billah M.M., Saha D. Internet of Things (IoT): A review of its enabling technologies in healthcare applications, standards protocols, security and market opportunities. *IEEE Internet Things J.* 2021;8:10474–10498. doi: 10.1109/JIOT.2021.3062630.
- [9] Aghdam Z.N., Rahmani A.M., Hosseinzadeh M. The role of the Internet of Things in healthcare: Future trends and challenges. *Comput. Methods Programs Biomed.* 2021; 199:105903. doi: 10.1016/j.cmpb.2020.105903.
- [10] Hamim, M., et al. (2022). IoT-Based Healthcare-Monitoring System towards Improving Quality of Life. *Sensors*, 22(19), 7552. [PMC9601552]
- [11] Ding, D., Sallam, E. A., Mohamed, R., & Mohamed, A. (2024). Comparative analysis of internet of things (IoT) in supporting healthcare systems. *Biosciences, Biotechnology Research Asia, Special Issue (1)*, 103-110.
- [12] Agali, S., Masrom, M., & Rahim, N. (2024). Internet of Things (IoT) in healthcare: A systematic review of use cases, benefits, and challenges. *International Journal of Scientific Research and Applications*, 4(3), 243-256.
- [13] Itransition. (2025). Healthcare IoT: Applications, Benefits, and Market Trends. [Itransition Healthcare IoT Report] (April 2025).
- [14]. Zazz. (2024). IoT in Healthcare Industry 2025: The Future of Medical Devices. [Zazz Blog] (December 2024).
- [15] Mostafa, A., et al. (2022). Application of Internet of Things and Sensors in Healthcare. *Sensors*, 22(15), 5632. [PMC9371210]
- [16] Aceto, G., Persico, V., & Pescapé, A. (2023). A review of IoT applications in healthcare. *Neurocomputing*, 523, 701-716.
- [17] MDPI. (2023). Healthcare Internet of Things (H-IoT): Current Trends, Future Directions, and Challenges. *Electronics*, 12(9), 2050.
- [18] ScienceDirect. (2023). The Internet of Things (IoT) in healthcare: Taking stock and moving forward. *Digital Health*, 9, 100044.