A STUDY OF THE APPLICATION OF THE INTERNET OF THINGS IN THE HEALTHCARE SECTOR IN DEALING WITH COVID-19 WITH REFERENCE TO AHMEDNAGAR DISTRICT: A RESEARCH AGENDA

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ABSTRACT

Given the technological advances in Internet of Things (IoT), it is interesting to see their applications in the healthcare sector. And especially with reference to covid-19, which has presented challenges like never before. The proposed study focuses on the applications of IoT for various aspects of combating the pandemic. It starts with diagnosis of the patients and extends up to the prevention. This paper frames the research objectives and hypotheses and also frames the proposed research methodology. Summarily, a research agenda is set to study of the application of the Internet of Things (IoT) in the healthcare sector in dealing with COVID-19 with reference to Ahmednagar District.

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Introduction

The Internet of Things (IoT) depicts the network of physical objects—"things"— that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial tools. Specialists are anticipating that the number of IoT devices should grow from 10 billion in 2020 to 22 billion by 2025.

In the course of recent years, IoT has become one of the main technologies of the 21st century. Since we can connect ordinary objects—kitchen appliances, cars, thermostats, baby monitors—to the internet by means of embedded devices, consistent communication is conceivable between people, processes, and things. By method for low-cost computing, the cloud, big data, analytics, and versatile technologies, physical things can share and gather data with negligible human intervention. In this hyperconnected world, computerized systems can record, monitor, and change every interaction between connected things. The physical world meets the computerized world—and they cooperate.

Before Internet of Things, patients' interactions with doctors were limited to visits, and tele and text communications. There was no way doctors or hospitals could monitor patients' health continuously and make recommendations accordingly.

Internet of Things (IoT)-enabled devices have made remote monitoring in the healthcare sector possible, unleashing the potential to keep patients safe and healthy, and empowering physicians to deliver superlative care. It has also increased patient engagement and satisfaction as interactions with doctors have become easier and more efficient. Furthermore, remote monitoring of patient's health helps in reducing the length of hospital stay and prevents re-admissions. IoT also has a major impact on reducing healthcare costs significantly and improving treatment outcomes.

IoT is undoubtedly transforming the healthcare industry by redefining the space of devices and people interaction in delivering healthcare solutions. IoT has applications in healthcare that benefit patients, families, physicians, hospitals and insurance companies.

The major advantages of IoT in healthcare include:

- **Cost Reduction**: IoT enables patient monitoring in real time, thus significantly cutting down unnecessary visits to doctors, hospital stays and re-admissions
- **Improved Treatment:** It enables physicians to make evidence-based informed decisions and brings absolute transparency
- **Faster Disease Diagnosis:** Continuous patient monitoring and real time data helps in diagnosing diseases at an early stage or

even before the disease develops based on symptoms

- **Proactive Treatment**: Continuous health monitoring opens the doors for providing proactive medical treatment
- **Error Reduction:** Data generated through IoT devices not only help in effective decision making but also ensure smooth healthcare operations with reduced errors, waste and system costs (Karjagi and Jindal 2021).

Given these technological advances, it is interesting to see their applications in the healthcare sector. And especially with reference to covid-19, which has presented challenges like never before. This study focuses on the applications of IoT for various aspects of combating the pandemic. It starts with diagnosis of the patients and extends up to the prevention. The covid-19 pandemic offers a unique window of opportunity to test the technological developments.

Literature Review

Kishor and Chakraborty (2021) have stated that Artificial Intelligence (AI) has been widely implemented in healthcare 4.0 for producing accurate and early results. The early prediction of diseases help doctors to take early decisions to save the life of patients. Internet of things (IoT) is working as a major catalyst in enhancing the power of AI applications in healthcare. The patients' data is captured by the IoT sensor and machine learning techniques are used to analyze the patient data.

Ratta et al. (2021) write that Internet of Things (IoT) is one of the latest innovations in Information Technology which connects the physical and digital worlds. It introduces a smart vision by enabling communication between humans and objects through the Internet. IoT has diverse applications in almost all the sectors like Smart Health, Smart Transportation, and Smart Cities, etc. In the healthcare applications, IoT eases communication between patients and doctors as the former can be diagnosed from a remote location in case of an emergency through wearable sensors and body sensor networks.

Puri et al. (2021) state that Internet of Things (IoT) and other technologies like artificial intelligence (AI), blockchain, and mixed

augmented reality (MAR) have revolutionized the concept of a smart ecosystem, wherein all life forms including the living and non-living, are connected to each other for the mutual sharing of data and information.

Kamal et al. (2020), have posited that, because of the global pandemic of COVID-19, there is a dire need to use existing technologies to their full potential. Internet of Things (IoT) is viewed as one of the most trending technologies with an incredible potential in battling against the coronavirus outbreak. The IoT contains a scarce network where the IoT gadgets sense the environment and send valuable information on the Internet. In this paper, we analyze the current status of IoT applications identified with COVID-19, recognize their deployment and operational challenges, and recommend potential opportunities to additionally contain the pandemic. Moreover, we perform investigation for executing IoT in which inward and outside factors are talked about.

Singh et al. (2020), have argued that, the current global test of COVID-19 pandemic has surpassed the provincial, radical, conceptual, spiritual, social, and pedagogical boundaries. Internet of Things (IoT) empowered healthcare framework is helpful for legitimate monitoring of COVID-19 patients, by utilizing an interconnected network. This innovation assists with expanding patient fulfillment and decreases the readmission rate in the emergency clinic. IoT execution impacts on decreasing healthcare costs and further develop the treatment result of the infected patient. Therefore, this current review-based exploration is endeavored to investigate, talk about, and feature the general uses of the very much demonstrated IoT theory by offering a viewpoint guide to handle the COVID-19 pandemic. At long last, twelve critical uses of IoT are distinguished and examined.

According to Kumar et al. (2020), the COVID-19 epidemic has caused a global fear for humanity. Notwithstanding technological progression, the utilization of face masks, hand gloves, and sanitizers are the main accessible preventives measures to stop the spread and transmission of coronavirus. Healthcare suppliers and clinical staffs are consistently in danger of disease as they manage the infected

individual at the forefront. The security of health care workers is fundamental as the quantity of infected health care works is expanding step by step. A definite literature review is done on a past epidemic outbreak and COVID-19 by utilizing reasonable keywords on SCOPUS. During the analysis of literature, a few challenges were discovered that confine the activity of the health care laborers and cause security issues for them. This exploration paper expects to distinguish the challenges faced by healthcare areas in managing this epidemic outbreak and to propose the potential arrangements as far as famous technologies like AI and IoT by doing a basic analysis of literature. The review contributes by identifying the issues and classifying them into physical, operational, resource-based, organizational, technological, and external health care challenges.

Ndiaye et al. (2020), have opined that, the novel coronavirus (COVID-19), announced by the World Health Organization (WHO) as a global pandemic, has carried with it changes to the overall lifestyle. Significant areas of the world business and economy have been influenced and the Internet of Things (IoT) the executives and system are no special case in such manner. This article gives a forward-thinking study on how a global pandemic, for example, COVID-19 has influenced the universe of IoT technologies. It takes a look at the commitments that IoT and associated sensor technologies have made towards virus tracing, tracking and spread mitigation. The associated challenges of deployment of sensor hardware in the face of a quickly spreading pandemic have been investigated as a feature of this survey article. The impacts of a global pandemic on the development of IoT structures and the executives have additionally been tended to, prompting the probable results on future IoT executions. By and large, this article gives an understanding into the headway of sensor-based E-health towards the administration of global pandemics.

According to Baskaran et al. (2020), the recent global pandemic, COVID-19 has carried exceptional changes to the livelihood of people from all avenues of life across the nation. As business as usual is as a rule gradually restored, it is likewise basically pivotal that the health

and wellness of members are guaranteed. Rather than the manual biometric system, facial recognition can be conveyed to check the presence of the members. Plus, a non-contact infrared sensor can be used to check for the body temperature of the people. In the event that the body temperature surpasses the threshold, an intimation will be sent to the higher specialists concerning the wellness of the individual, otherwise, their essence to the organization/institution will be noted. Furthermore, utilizing a QR scanner, the health history of every person according to the ArogyaSetu app will be taken into accord. The participation checking highlight has been clubbed with health verification so every representative will mandatorily report before the system since presence for work is critical to everyone. The data generated by the static portal setup is recorded by the gadget every day which will then be transferred into a database and stored on the Cloud.

Research Gap

Though there is ample research on IoT and COVID-19, there are limited studies in the Indian context. Moreover, there are no studies focused on Ahmednagar District. Additionally, there are only a few studies which are comprehensive and cover diagnosis to prevention. Our study endeavors to fill these research gaps.

Research Objectives and Hypotheses

The study has the following research objectives:

1) To study the applications of IoT in the healthcare sector
2) To study the applications of IoT for COVID-19 diagnosis
3) To study the applications of IoT for COVID-19 patient care
4) To study the applications of IoT for COVID-19 patient cure
5) To study the applications of IoT for COVID-19 prevention

Based on the research objectives following hypotheses have been formulated:

Ho1: There are no significant applications of IoT for COVID-19 diagnosis

Ha1: There are significant applications of IoT for COVID-19 diagnosis

Ho2: There are no significant applications of IoT for COVID-19 patient care

Ha2: There are significant applications of IoT for COVID-19 patient care

Ho3: There are no significant applications of IoT for COVID-19 patient cure

Ha3: There are significant applications of IoT for COVID-19 patient cure

Ho4: There are no significant applications of IoT for COVID-19 prevention

Ha4: There are significant applications of IoT for COVID-19 prevention

Proposed Research Methodology

- The study will be conducted based on primary research through survey of doctors, nurses and paramedical staff.
- Assuming 1.34 doctors per 1,000 people (All India average) and the population of Ahmednagar district as 45 lacs (Google.com 2021), the population of doctors comes to around 6,000. The sample size for 95% confidence level comes to around 361 which was rounded off to 400.
- Convenience sampling method will be used.

- The research hypotheses will be tested using a questionnaire which will have 4 sections.
- Each section will have 10 questions and responses will be sought on 5-point Likert scale.
- For each of the sections, agreement/disagreement score will be calculated
- This overall average score (for the ten questions) will be compared with hypothesized population mean of 50% connoting an event by chance.
- Hypotheses will be tested using t-tests.

Conclusion

There are several advances in the Internet of Things technology. It has several applications in the healthcare sector. Moreover, these applications are used to combat a pandemic crisis such as covid-19. This paper sets the research agenda to study of the application of the Internet of Things (IoT) in the healthcare sector in dealing with COVID-19 with reference to Ahmednagar District.Research objectives, hypotheses and methodology to test these hypotheses have been framed.

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