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THE IMPACT OF INTERNET OF THINGS (IOT) IN HEALTHCARE (A COMPREHENSIVE LITERATURE REVIEW)

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ABSTRACT

Purpose- The basic goal of a literature review is to locate, specify, map, and analyze the present corpus of relevant literature in an objective, methodical, and easily replicable way. A well-structured literature review that includes a wide range of publications and research approaches produces a complete and in-depth analysis that considers obvious and contextual relationships We chose bibliometrics for three key reasons in this analysis. First, a bibliometric analysis is more reliable and scalable than other approaches to text analysis, including content analysis. The literature review on IoT in healthcare serves as a comprehensive investigation into the multifaceted landscape of Internet of Things (IoT) technology within the healthcare domain. Its overarching objective is to elucidate the myriad ways in which IoT applications, ranging from wearable sensors to remote monitoring systems and smart medical devices, are reshaping the delivery of healthcare services and impacting patient care. By synthesizing existing knowledge, this review endeavors to provide a holistic understanding of IoT's role in healthcare, spanning its utilization, impacts, challenges, and future prospects. Through a critical examination of empirical studies and case reports, it aims to discern the tangible benefits brought about by IoT implementation, including improvements in operational efficiency, cost-effectiveness, and clinical decision-making processes. Moreover, this review endeavors to shed light on the complexities and hurdles associated with IoT adoption in healthcare, encompassing concerns such as data security, interoperability issues, privacy considerations, and regulatory compliance. Concurrently, it will explore emerging trends and technological advancements, delineating potential opportunities for innovation such as AI-driven predictive analytics, blockchain-enabled data sharing, and the integration of IoT with edge computing and 5G networks. Ultimately, the insights gleaned from this review aspire to inform and guide healthcare practitioners, policymakers, researchers, and industry stakeholders in making informed decisions, shaping strategic initiatives, and delineating future research agendas aimed at harnessing the transformative potential of IoT to revolutionize healthcare delivery and enhance patient outcomes on a global scale.

Aim- The aim of this comprehensive literature review on the utilization of Internet of Things (IoT) technology within the healthcare sector is to provide a thorough understanding of its multifaceted impacts, challenges, and future potential. By synthesizing existing research and empirical evidence, the review seeks to elucidate the diverse applications of IoT in healthcare, ranging from remote patient monitoring and wearable devices to smart medical equipment and data analytics platforms. Through a critical examination of the literature, it aims to evaluate the tangible benefits of IoT adoption, including improvements in patient care delivery, clinical decision-making processes, operational efficiency, and cost-effectiveness. Moreover, the review endeavors to identify and analyze the challenges and barriers hindering the widespread implementation of IoT in healthcare, such as data security concerns, interoperability issues, regulatory compliance, and privacy considerations. By exploring emerging trends and technological advancements, including the integration of IoT with artificial intelligence, blockchain, edge computing, and 5G networks, the review seeks to delineate future opportunities for innovation and transformative change in healthcare delivery models. Ultimately, the insights generated from this review aim to inform healthcare stakeholders, policymakers, researchers, and industry leaders, enabling them to make informed decisions, address challenges, capitalize on opportunities, and shape the future trajectory of IoT-enabled healthcare to enhance patient outcomes and improve population health on a global scale.

Objective - The potential of Internet of Things (IoT) technology to ease the burden on healthcare systems brought on by an aging population and an increase in chronic sickness has garnered significant attention in recent years. In light of the fact that standardization is a major barrier to advancement in this field, this article suggests a standard model for use in next IoT healthcare systems. Over the past ten years, the Internet of Things (IoT) has completely changed the way we use technology. Through patient and hospital cost reduction, improved mobility, efficient connectivity, monitoring, and data collection, smart healthcare aims to improve people's lives and well-being. One of the hottest and most popular issues that requires in-depth research is IoT in healthcare. There hasn't been a review done recently to clarify the scope of IoT facilitating in healthcare systems: reasons, obstacles, published paper characteristics, and research in the field. In order to enable IoT in healthcare services and applications, a thorough systematic review of the selected publications published between 2015 and 2022 is presented in this study. For quite some time, there has been a close relationship between the technology and healthcare sectors. However, as the fields of big data and the Internet of Things (IoT) continue to grow quickly, new opportunities appear. Our solution uses the Internet of Things (IoT) to give healthcare providers a round-the-clock, real-time service to remotely monitor patients at home and get alerts in the event of an emergency. Next, this survey study discusses the most recent research on each model component, assessing its advantages and disadvantages. shortcomings and general applicability for an IoT-enabled wearable health care system. There is a presentation of the security, privacy, wearability, and low-power operation challenges that the Internet of Things in healthcare must overcome, along with suggestions for future research approaches.

Keywords: IoT in Healthcare Overview, Applications in Healthcare, motivations and challenges , methodology , remarks, conclusion.

1. INTRODUCTION

Overview of IOT in Healthcare

Much recent research has focused on the Internet of Things (IoT), which has been widely recognized as a viable option to ease the constraints on health care systems. A significant portion of this research examines patient monitoring for particular illnesses like Parkinson's disease or diabetes. Additional research aims to fulfill particular objectives, such supporting patients' recovery by continuously observing their development. While not much research has been done on the subject, similar works have also indicated that emergency healthcare may be an option. A number of related works have already examined particular IoT healthcare technologies and sectors. A thorough analysis is provided in, emphasizing on solutions that are currently on the market, potential uses, and unresolved issues. Every subject is examined independently, instead of rather than as a component of a larger system. The integration of data mining, storage, and analysis into a system is discussed in passing in. the Internet of Things' (IoT) technology advancements and the new demands and directions for healthcare applications work very well together. IoT is poised to play a significant role in all facets of health management due to the rapid expansion of IoT device deployment and the growing desire to make healthcare more proactive, personalized, and cost-effective. For the purposes of this discussion, we will refer to this significant area of IoT as the Healthcare Internet of Things (HIoT). Personal and clinical are the two main subcategories into which HIoT can be divided. Smart clothing and activity/heart rate trackers are examples of personal wearable technology. as well as smartwatches for self-tracking. These multipurpose gadgets are meant to be used by patients independently of medical professionals and are not subject to stringent regulations. Clinical HIoT devices are developed especially for health monitoring under a doctor's supervision and with their participation. A number of current surveys focus on particular facets of HIoT systems. Applications for toddlers and children as well as medical IoT devices with a personalized health care system focus have been examined. Applications concentrating on healthcare solutions using smartphones, ambient assisted living (AAL), and wearable devices, as well as applications of remote health monitoring systems such as body temperature monitoring and senior care, have been thoroughly researched. Among the newer technologies, the Internet of Things requires its own hardware and software. Consequently, the pace of growth of this various nations have various technologies. Each community has therefore made an effort to utilize this technology as effectively as possible. Because of this, different nations employ this technology in their health services to differing degrees in terms of quantity and quality. As a result, an effort is made in this part to demonstrate the authors' objectivity in the papers they chose, the range of nations they examined, and their objectivity in posing questions by outlining a systematic review procedure. This study adhered to a systematic review process, which is widely recognized as high-quality evidence, in order to conduct a more effective and genuine review.

Applications of healthcare in IOT- IoT system designers should be aware of the constraints that will prevent their systems from functioning as intended, even though their systems should be particularly created to meet the needs of their intended use. Now, we will highlight some of the most prevalent requirements and limitations of HIoT devices, some of which may not be applicable to all potential uses.

Decision Support: The function of decision support in an Internet of Things management system is paramount. The computer should analyze the data gathered from several sources and provide healthcare experts with a thorough format, acting as a support tool for the professionals. Depending on its intended use, an application may offer several kinds of decision support. An automated warning system that sounds an alert under severe conditions, for instance, can be needed for a particular application. The healthcare organization (HCO), the physician, the patient's caregiver, or the patient themselves may all receive this notice.

Latency Tolerance: The design of a system can also be impacted by latency tolerance. Applications that work with critically ill patients that require continuous real-time monitoring must have the fastest possible alert response times. On the other hand, some programs meant for less urgent situations might be able to put up with more delay.

Computational Intensity: The system needs a certain level of processing power to analyze the volume of data it collects. The amount of computing power required for the system depends on several factors, including the quantity of sensors, frequency of signal sampling, sample precision, and overhead imposed by encryption techniques. Additionally, more computational power is required for applications that need lower latency. Independent of the total amount of data, machine learning methods employed in a system may potentially impose additional computational intensity. For instance, two algorithms using the same input data may necessitate varying computational intensities due to their respective natures.

Power Consumption: Since most physiological sensor technology is wearable, batteries are required to power the sensors. Continuous signal collecting and monitoring require optimizing power usage to increase battery life (using energy-aware algorithms as well as hardware configurations).

Data Communication Rate: Physical signals are sent over a WBAN to a local concentrator in the majority of Internet of Things systems. The amount of data that may be obtained in a given amount of time is limited by the bandwidth constraint on the communication link between the concentrator and the WBAN. Prior to being transmitted to a local concentrator, the captured data may need to undergo some pre-processing. additionally, in certain circumstances—for example, when certain encryption techniques incur a substantial overhead—the quantity of the data after pre-processing may exceed that of the data when it was transferred from the WBAN.

Wearabe Health Care System: WBANs have been highlighted as a crucial part of an Internet of Things-based healthcare system; hence, the creation of precise, low-form-factor sensors is necessary for the system's effective growth. Non-invasive and non-obtrusive sensors are the main topic of this article; implanted sensors are not included. Five basic sensors are taken into consideration: three are used to monitor the vital signs of body temperature, respiration rate, and pulse; two more are used to monitor blood pressure and blood oxygen, which are both frequently measured in a hospital setting.

2. PULSE SENSORS

Pulse, which is arguably the most frequently observed vital sign, can identify a variety of life-threatening disorders, including vasovagal syncope, pulmonary embolisms, and cardiac arrest. Numerous studies have been conducted on pulse sensors, both for fitness tracking and medical applications. A person's pulse can be detected via the fingertip, wrist, earlobe, chest, and more. While quite accurate, earlobe and fingertip readings are not very wearable. Although wrist sensors are usually thought to be the most pleasant for a long-term wearable system, a chest-worn system is still wearable. There are numerous fitness monitoring wrist watches and chest straps on the market that can measure your pulse. These consist of TomTom Spark Cardio, HRM-Tri by Garmin, and H7 by Polar FitBit Pure Pulse. But each of these businesses makes it clear that their products are not intended for medicinal use only and shouldn't be depended upon to identify medical issues. Because of this, a vital health monitoring system cannot be directly integrated with the sensing systems used by these devices. Several studies have been done on appropriate pulse sensing technique. Pressure photoplethysmographic (PPG), ultrasonic, and radio frequency (RF) sensors are among the sensor types that have been invented, employed, and examined in recent studies.PPG sensors work by using an LED to send light into the artery and a photodiode to collect the light that is not absorbed by the blood. It is possible to record variations in light intensity and ascertain a pulse rate in this way. PPG sensors are used to detect blood oxygen, pulse, and pulse rate variability all in one tiny wrist-worn sensor. An accelerometer is utilized to detect movement since movement impacts the precision of pulse measurements from PPG sensors. The gadget enters a low power mode and stops recording pulses when motion is high. This isn't really appropriate because pulse matters when there's a lot of motion, such when someone is having heart problems or experiencing seizures while exercising. It would be preferable to increase pulse sensor accuracy while in motion rather than ignoring readings during periods of high movement. By utilizing two distinct LED light intensities and comparing the quantity of light received at the photodiode, the effects of motion on PPG sensors are lessened. This approach significantly reduces motion artifacts, resulting in a noticeable improvement in signal quality. By applying pressure with their fingertips, pressure sensors are meant to resemble a medical practitioner manually monitoring the radial pulse. The sensor is firmly pressed against the wrist, and pressure is continuously monitored to provide a pulse waveform. In, pressure and PPG sensors are coupled, and arrays of nine PPG sensors and one pressure sensor are used to create pulse sensor modules. Multiple wrist locations are used to take a person's pulse, which results in accurate data that can be used to diagnose conditions like diabetes. pulse sensing diagnostics that compare ultrasonic, PPG, and pressure sensors. All three had reasonable accuracy, but the authors concluded that different types of sensors were needed for different conditions; pressure worked best for arteriosclerosis, whereas ultrasonic worked best for diabetes. An et al. used a R F array module to develop a non-conventional pulse sensor that measures multiple wrist positions. in the event that movement causes the received pulse signal to become noisy at any point. When compared to a reference signal, reasonable pulse measurements were obtained, but they still don't seem to be as clear as those from the more conventional sensor types. Although there is potential for this kind of pulse sensor, more development is obviously needed to ensure its dependability in a critical healthcare situation. It is highly advised that PPG sensors be utilized for pulse sensing based on these studies. They have been shown time and time again to be reliable pulse rate monitors, and methods have already been created to minimize the effects of noise on signal quality through algorithms.

3. RESPIRATORY RATE SENSORS

Respiratory rate, or the quantity of breaths a patient takes in a minute, is another important indication. Monitoring respiration could help diagnose diseases including tuberculosis, lung cancer, apnea episodes, asthma attacks, hyperventilation brought on by panic attacks, and more.

Owing to the significance of breathing, numerous earlier studies have created sensors to gauge the rate of breathing. Examining earlier studies reveals a variety of respiratory rate sensor types. The first is a thermistor-based nasal sensor. The idea behind these sensors is that exhaled air has a higher temperature than the surrounding air. As a result, the sensor counts the number of breaths taken by using the rise and fall in temperature. This is demonstrated to function rather well, but precision can be hampered by external temperature changes—for instance, if the wearer is a cook in a kitchen. Additionally, because it is conspicuous and obtrusive, it is not very wearable. The breathing rate can also be estimated from echocardiogram (ECG) readings. This technique, known as ECG Derived respiratory (EDR), is employed to identify apnea episodes and ascertain respiratory patterns. Although it is again constrained by wear ability, this approach measures respiratory rate quite accurately. In addition to being uncomfortable, extended usage of ECG contacts could irritate the skin. Furthermore, ECG contacts must be changed on a regular basis because they are not reusable.

A microphone can be used to measure respiration and determine respiratory rate. The goal of this study was to identify wheeze, a symptom that asthmatics frequently experience. The drawback of utilizing a microphone is that it would be very vulnerable to outside noise, making it unsuitable for long-term wear. A fiber optic sensor in an elastic substrate that was sensitive enough to detect vibrations brought on by breathing was created in one study. This was demonstrated to function in a single test, but it's unclear if it would function effectively in other scenarios. This delicate substance would probably be sensitive to vibrations from other sources, such as footsteps. There should be more testing done. A sensor of the pressure kind was evolved. One of the two parallel capacitive plates is sitting on the abdomen. The plates move apart while breathing and then together during exhale and inhalation, respectively, making it possible to calculate the respiratory rate. When compared to an asal sensor, this study's respiratory rate computations had a 95% confidence level. In comparison to the nasal sensor it was compared to, this is significantly more wearable and quite accurate. But because of its nature, a pressure sensor could produce noise if it is subjected to outside pressures, like walking into a breeze. Using a stretch sensor is a popular technique for determining breathing rate. Stretch sensors are ones whose characteristics alter when tensile force is applied, such as being expanded when breathing in. The ferroelectric polymer transducer used in the design of the sensor produced a charge when a tensile tension was applied. Respiratory rate can be calculated by monitoring variations in this charge. Although the sensor seemed to produce a clear signal, the accuracy was not confirmed by comparing it to respiratory rate determined using alternative methods. The respiratory rate sensors in and were dependent on variations in resistance. Resistance rises when a tensile force is applied to the sensor. The breathing rate can be computed using the voltage variations brought about by different resistances. While it has been demonstrated that all stretch sensor types are capable of accurately estimating respiratory rate, Atalay et al. acknowledge the existence of motion artifacts while walking and other motions. Furthermore, it was discovered that when sitting at a desk, breathing was accurate to within 3.3 breaths per minute; the error margin grew with movement. As a result, one of these sensors' limitations is that other movements may apply tensile force to the sensor in a way that confuses it for breathing. It appears that a wide variety of sensor types are available for determining respiratory rate. The wearability of the sensor consequently becomes the primary consideration when selecting a type for a WBAN. Thus, it is highly advised that stretch sensors be included in systems in the future. Rather than creating wholly new sensors, future effort should concentrate on creating algorithms and methods to increase resilience against motion utilizing present sensors.

Body Temperature Sensors - Body temperature is the third vital sign, and it can be used to identify fevers, heat stroke, hypothermia, and other conditions. Body temperature is therefore a helpful diagnostic tool that ought to be a part of a wearable healthcare system. Thermistor-type sensors are used in all recent studies pertaining to body temperature measurement. Positive-temperature coefficient (PTC) sensors were taken into consideration in and, but typical negative-temperature-coefficient (NTC) type temperature sensors were employed in and. The thermistors were demonstrated in every study to measure a range of temperatures that is appropriate for monitoring the human body, with error rates that are tolerable. It is therefore highly advised that future system designers stick with these sensor kinds. How close the sensor can be positioned determines how accurate the temperature sensor can be to the anatomy of humans. As a result, a number of studies concentrated on creating sensors that could be applied straight to human skin and were printed onto thin, flexible polymers with adhesive backing. Although this is an intriguing development, research in demonstrates that a temperature sensor incorporated into textiles can also measure temperature rather accurately. Thus, until electronics printed on flexible polymer can be made more easily, system designers are advised to employ fabrics to carry temperature sensors.

Pulse Oximetry Sensors- Pulse oximetry measures the level of oxygen in the blood. Much of this light is absorbed by the hemoglobin in the blood, but not all. The amount of light not absorbed is measured by receiving photodiodes, and the difference between the received lights is used to calculate blood oxygen. LED lights can either be passed through an appendage to a photodiode on the opposite side, or can be directed at an PPG sensors for pulse oximetry angle so that some light reflects to a photodiode on the same side of the appendage. a low-power pulse oximeter is designed with the aim of improving wearability. The first- named minimum SNR tracking- continuously calculates the current signal-to-noise-ratio and adjusts the length of time that the LED is in the on state for accordingly- the higher the SNR is, the longer that the LED needs to be on to gain accurate readings. This was designed to detect blood oxygen levels even when the patient is suffering from shock, hypothermia, or other conditions that may cause blood centralization and lead to pulse being undetectable at the fingertips. Reasonable accuracy in measuring blood oxygen levels was achieved in clinical testing on surgical patients, but the authors concluded that their sensor should be used in addition to finger pulse oximeters, not as an alternative. A reflective pulse oximeter was designed to be worn on the wrist. Overall, the works in improving pulse oximetry do not focus on finding new means to measure blood oxygen saturation, but instead focus on making wearable devices that utilize the well-known existing techniques.

Early Warning Score- A system known as an early warning system is used to identify signs of health decline early on and lessen the effects of abrupt, drastic changes in health. With the help of a method known as the Early Warning Score (EWS), a system of this kind can determine whether a patient is at risk of declining by calculating various scores from their observation chart through repeated physiological measurements of their vital signs. These scores are then combined to create a composite score. Research in this area has demonstrated that patients frequently exhibit clinical deterioration symptoms up to 24 hours before a significant clinical case necessitating a comprehensive response. Five physiological parameters can be used to compute the simplest form of score: body temperature, blood oxygen saturation, pulse rate, systolic blood pressure, respiration rate, and degree of consciousness. A minimum score of 0 and a maximum score of 3 are assigned to each parameter, from which the total score is derived. Based on the outcomes of the early warning score calculation, the patient's treatment plan may be modified. A patient receiving higher scores receives a higher level of medical treatment, such as being assessed by a health specialist or being admitted to an intensive care unit. Lower scores cause the frequency of observation to change.

RELATED WORK

The first time an early warning score was suggested as a strategy to stop health decline was in 1997. Throughout its implementation in hospitals, this early EWS approach underwent multiple modifications to improve and streamline the algorithm and procedure. A standardized version (SEWS), a modified early warning system (MEWS), and eventually national early warning scores (NEWS) were the results. The amount of medical parameters that are recorded and the score assigned to each vital sign within the range of values are the primary differences between these systems. Several nations, including Sweden and New Zealand, employ the EWS principle, but with some modifications. Although hospitals have found great benefit from using this grading system Numerous hospitals are now required to utilize electronic vital sign recording because of reports concerning failures resulting from poor quality data collection and inaccurate EWS score computation, which have the potential to save lives and lower healthcare costs. Using EWS, a system called Intelli Vue Guardian Solution identifies hospital patients who are at risk of deteriorating and assists caregivers in avoiding expensive transfers or readmissions to the intensive care unit. The usefulness and wearability of these devices at home are not taken into consideration; they are only intended to function with hospital monitoring systems.

4. SYSTEM ARCHITECTURE

The system architecture of our IoT-based early warning system The system architecture includes 3 main components:

1. Sensor Network: In the sensor network medical parameters are recorded by wearable sensors. Sensors are categorized into three groups based on their data conversion rate and their function. The first group of sensors includes high date rate sensors used for streaming-like real-time parameters (e.g., ECG signal). The second group comprised of sensors that read and record data at a lower data rate such as body temperature and environment sensors. The last group includes sensors which are not fully automated and are periodically used by patients or home care givers. The values read by these sensors (e.g., blood pressure) are added to the system manually.

2. e-Health Gateway: The gateway, receives data from several sensors, performs protocol conversion, and provides some services such as data compression and storage in offline mode. At the gateway layer, there can be two different kinds of approaches depending on the availability of Internet connection. If the e-Health gateway has the Internet access, it will send the real-time non-pre-processed signals (e.g., ECG signal) to the cloud server. In this approach, other data from the first sensor type can be pre-processed and the numerical results along with other data from the second type sensors will be sent to the cloud server. In case unavailability of Internet at the gateway, the e-Health gateway will store the compressed raw data and results of local pre processings in its local database. As soon as the gateway is reconnected to Internet, it will send first the calculated values and then compressed raw data packages to the cloud server.
3. Back-End System: The back-end system has two different sections:

   A cloud-based back-end infrastructure including data storage, data analysis, decision making etc. user interface which acts as a dashboard for medical care givers together with performing user control and data visualization. The cloud server receives different types of sensor data using corresponding protocol and stores it in the database. At this stage, early warning score is computable when the server has received every single part of parameters needed for estimation of EWS and based on the final score, proper alerts will fire in case of emergency. Cloud server is also responsible for providing the administration control panel for health experts with real-time health data visualizers and user interface for patients and in-home care give Motivations for IOT in Healthcare.

Technology is driving a tremendous revolution in the healthcare industry. The Internet of Things (IoT) stands out as a particularly promising sector, having the potential to transform how healthcare is delivered and managed. This essay investigates the primary motives driving the adoption of IoT in healthcare, incorporating insights from relevant research. One of the key drivers for IoT in healthcare is the promise of improved patient care. IoT devices can provide continuous remote monitoring of vital signs, chronic illnesses, and medication adherence, allowing patients to take a more active role in their health management. This real-time data enables faster interventions and individualized treatment strategies, eventually leading to improved health outcomes. Another important motivator is the possibility for preventive healthcare. Wearable sensors and smart gadgets can collect useful information about activity levels, sleep habits, and physiological indicators, enabling for early detection of potential health problems. This preventative approach can greatly cut healthcare expenses associated with treating advanced stage disorders. Furthermore, IoT holds enormous potential for improving chronic illness management. IoT devices can help people maintain their health and avoid complications by continuously monitoring chronic illnesses such as diabetes or heart disease. Furthermore, real-time data can enable remote consultations with healthcare specialists, improving patient engagement and overall care quality. The rising expense of healthcare also drives the use of IoT. IoT has the potential to minimize hospital admissions and resource use by encouraging preventative treatment, remote monitoring, and chronic condition self-management. Furthermore, the ability to collect and analyse large amounts of healthcare data might pave the way for optimal resource allocation and enhanced healthcare system efficiency. Another reason to use IoT in healthcare is improved accessibility and remote care. This technology has the potential to help close geographical gaps in healthcare delivery, particularly in rural or underserved areas. Patients living in rural areas can benefit from virtual consultations, medication adherence monitoring, and even robotic-assisted procedures made possible by IoT technologies.

Challenges for IOT in Healthcare: The Internet of Things (IoT) has emerged as a transformative force in healthcare, promising to improve patient care through continuous monitoring, remote diagnostics, and personalised medicine. By connecting medical devices, wearables, and sensors to a central network, IoT provides a look into the future of proactive healthcare management. However, despite its enormous promise, the integration of IoT in healthcare confronts a slew of problems that must be overcome before widespread use. One of the most pressing concerns is data security and privacy. IoT devices capture a large amount of sensitive patient data, making them a potential target for attackers. Breaches can reveal personal health information, resulting in identity theft and prejudice. Furthermore, guaranteeing user control over their data and establishing unambiguous ownership rights are challenging difficulties. Another obstacle is the technological complexity of IoT integration. The wide range of devices and communication protocols can cause compatibility concerns, preventing flawless data transmission. Furthermore, providing dependable and secure data transmission across large networks remains a challenge, particularly in remote places with low capacity. The constant flow of data can potentially overload current healthcare IT infrastructure, necessitating considerable changes to ensure effective storage, processing, and analysis. Beyond the technical obstacles, the human component poses its own set of issues. User acceptance and uptake of IoT-based healthcare solutions are strongly dependent on usability, affordability, and trust. Concerns regarding data privacy and potential job displacement in the healthcare industry may further limit mainstream adoption. Furthermore, incorporating IoT seamlessly into existing healthcare procedures necessitates training and cultural shifts among healthcare practitioners. Despite these obstacles, the potential advantages of IoT in healthcare are obvious. By addressing these concerns head on, we can pave the way for a future in which the Internet of Things empowers people, enhances healthcare delivery, and transforms disease prevention and management.

Here are a few crucial areas requiring additional study:

Creating strong cybersecurity defenses: It's critical to put in place reliable encryption methods, safe authentication procedures, and explicit data governance guidelines.

Standardization and interoperability: Creating common communication protocols would guarantee smooth data transfer across various systems and gadgets.

Investing in infrastructure: Data security and effective analysis depend on upgrading healthcare IT infrastructure to manage the volume of data.

Design with the user in mind: Building confidence and encouraging adoption requires creating user-friendly, reasonably priced IoT solutions that cater to patient requirements and concerns.

Ethical considerations: It is imperative that ethical implementation address data privacy concerns, ensure patient autonomy, and alleviate job displacement anxiety in the healthcare sector.

5. METHODOLOGY

The objective of this review was to thoroughly locate and evaluate academic works examining how the Internet of Things (IoT) is affecting healthcare. A methodical search approach was used with the Scopus database to accomplish this.

Choose a Database:

Scopus was selected because of: Broad coverage: Scopus has a greater selection of indexed academic journals than other databases such as IEEE Xplore, Web of Science, and ProQuest.

Effective reference management: Scopus has special features that make it simple for scholars to compile and evaluate references from a variety of publications.

Reputable source: Elsevier, Taylor & Francis, Emerald Insight, and other prominent publishers' academic journals are among the trustworthy ones that Scopus is known for including.

Search Strategy: To find pertinent publications, a thorough search string was created. Terms pertaining to technology (IoT, Internet of Things, IoMT, etc.) and healthcare (healthcare, health, medical, etc.) were included in this string. The papers' names, abstracts, and keywords were all included in the search. OR ("wireless body network*" OR "body sensor network*" OR "wireless body area network*" OR "body area network*" OR rehabilitation OR physician* OR e health OR "e-health" OR "m health" OR medication OR telemedicine) AND ("IoT" OR "Internet of Things") OR "IoMT" OR "Internet of Medical Things" OR "Internet of Health* Things" OR "IoHT" OR "Internet of Dental Things" OR "IoDT")

Criteria for Inclusion and Exclusion: Particular inclusion and exclusion criteria were used to guarantee the accuracy and applicability of the information retrieved:

Publication Type: Only reviews and journal articles were taken into account. Excluded materials included books, chapters, conference proceedings, notes, editorials, and reports.

Language: Only publications written in English were included in the search.

Publication Date: In order to guarantee a thorough yet current dataset, the search was carried out through July 31, 2022.

Procedure for Selection: Numerous publications (26,816) were found in the first search. A multi-stage selection procedure was used to hone the findings and concentrate on the most pertinent studies:

Subject Area Exclusion: To guarantee thorough coverage, no particular subject areas were restricted.

Publication Type Exclusion: Books, chapters, and other non-relevant publication types were eliminated (16,300 publications) in accordance with the inclusion criteria.

Language Exclusion: A total of 10,236 publications written in languages other than English were disregarded.

Manual Screening: The remaining papers (10,236) were examined by hand by three researchers from the research team. This entailed making sure there was a clear link between IoT applications in healthcare and the titles, abstracts, and complete texts (if needed). Articles that were limited to applications in the non-human health domains (plant, animal, and soil) were not accepted.

Consensus Building: After comparing their results, the reviewers resolved any disagreements by deliberation and consensus-building decision-making.

Final Choice: A total of 2,990 publications were determined to be directly related to the influence of IoT in healthcare after this stringent selection process. This extensive literature evaluation was built from these papers.

6. REMARKS

As a comprehensive review, we aimed to be objective regarding all selection and research features, following the strategy given at the beginning of the work. As a result, a concise summary of the study's shortcomings follows.

This review examines publications published between 2015 and 2022, which limits the conclusions addressed. The study searched for relevant literature using keywords such as "healthcare", "health care", "health-care", "medical system", and "health" in conjunction with "internet of things" and "IoT". This may have resulted in omitting some related articles from the databases. Future researchers could include terms like "e-health", "m-health", and "electronic health" in their search queries to further investigate the literature. Articles were also examined in light of established aims. This review's conclusions are limited by examining publications published throughout the researched and intended timeframe of the study to guarantee that relevant and recent articles were obtained. Given that these studies were conducted in several countries, some of the issues may be unique to certain places and not applicable to other locales. As a result, the problems highlighted in this article should be considered with caution. This page only reviews articles that are written in English. Related articles in other languages may be ignored. This may seem like a small limitation, but it is not a source of bias because most reputable magazines are published in English. This article highlights problems that may necessitate empirical testing depending on the location of IoT implementation in healthcare. This study's literature search included review articles. Few studies have explored the use of IoT in healthcare and service delivery globally. Several researchers in this study expressed serious worries about the urgent need to build real-time monitoring systems in response to the growing number of persons with impairments and chronic conditions. This is especially crucial in Malaysia's healthcare system, as the aging population is expected to account for 7.2% of the total population by 2020. As the population ages and more people develop chronic conditions, healthcare facilities will face increased demand. When intending to implement IoT in Malaysia's healthcare system, policymakers and IoT developers must take into account the current aging population. Currently, the domain of smart healthcare service delivery to care for chronically ill patients needs to be expanded. Developing embedded and disruptive sensors, along with real-time remote tracking and monitoring, has the potential to improve care for people with chronic conditions globally.

7. CONCLUSION

Researchers and authorities worldwide aim to leverage the Internet of Things (IoT) to enhance healthcare services and provision. Several papers on IoT have been published recently. However, the use of IoT in Researchers have focused extensively on the healthcare system and its impact on human lives. This article summarizes research on the use of IoT in healthcare systems to maximize benefits for patients, doctors, hospitals, governments, and providers. An SLR of 106 articles is selected and examined using a specified procedure. This article highlights the motivators for researchers and clinicians to use IoT in healthcare. To simplify the explanation, the observations were separated into four categories: systems, users, cost, and data, each with subcategories. Most studies on IoT in healthcare have identified several challenges, including integrating IoT with smart gadgets and vehicles for patient monitoring, developing algorithms for big data due to the growing population of chronic disease patients, and managing resources for cloud and fog computing. Other key constraints are technical requirements and performance enhancements.

8. REFERENCES

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