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Smart Environmental Monitoring for Potential Health Challenge

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ABSTRACT
In the past ten years, the prevalence of diseases connected to poor indoor air quality has grown. Indoor airborne pollutants are one of the top ten possible risks to the general public. Furthermore, it seems that the health impact of indoor air pollution is far greater than that of outside pollution. Numerous general indicators and clinical appearances of sickle cell disease, which can create a multitude of symptoms in each side of the respiratory system, the surface of the skin, the eyes, and the nerve systems, have been connected to indoor air quality, according to several study. The study uses ventilation to regulate the air's temperature, airborne chemical levels, and relative humidity in order to generate relatively comfortable spaces and control indoor air quality. When studying the airflow patterns and the migration of polluting particles throughout occupant zones, computations are helpful. As a result, several scientists have employed numerical modeling to analyze the behavior of airflow and hazardous levels. The purpose of the research is to deal with health difficulties linked with indoor surroundings. To establish and deal with the study's goals, important literature was studied. In order to uncover insufficient interior temperature constraints that could create health concerns to occupants, a qualitative approach was employed to conduct out research that covered comprehension of meningitis illness and indoor temperature needs. As part of the real aspect, the study then proposed an initial design that uses micro sensors and an artificial intelligence module emulated in an Adriano microcontroller to deliver precise indoor condition assessment.

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INTRODUCTION

In Every summer, there is excessive rise in temperature, less atmospheric humidity, dry dusty wind [1]. Living in this environment puts people prone to respiratory infections that create serious public health concern. Among these health issues is cerebrospinal meningitis, which is mostly brought on by the Neisseria meningitides bacteria [2]. Bacterial meningitis is an infection of the meninges, covering of the brain and spinal cord. Symptoms of the sickness include stiff neck, high fever, rash, severe headache, vomiting, and confusion [3]. This form of disease is severe in the sense that even with fast diagnosis, 5-10% of patients often die within 24-48 hours of symptom onset.

Currently, hot climatic areas, such as sub-Saharan Africa, the Arabian continents, and some parts of Asia, are at the forefront of the annual global outbreak of cerebrospinal meningitis [1]. The government and international health organizations have recently tried to avoid this seasonal illness by making a vaccine available to teenagers aged 11 to 18 [4]. However, despite widespread vaccination campaigns, routine immunization is impractical, especially in Nigeria, since the vaccine usually only provides protection for three to five years. Recent report revealed that

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vaccine is not sufficient to protect the population at large [5].

In addition to preventive vaccination, some of the control measures during the outbreak in places like Nigeria include enhanced epidemiological surveillance, prompt case management, and mass vaccinations in outbreak areas. Real-time monitoring and awareness play a vital role in preventing people contaminating with this deedless disease. Previous research efforts have demonstrated that a variety of environmental monitoring including humidity, temperature, air acceleration and many other factors, are monitored within the building in real time and data is stored in cloud environment and assess using data analytic techniques or machine learning algorithm to make prediction of possible useful information [6]. Today Internet of Things (IoT) innovation is one of the efficient and accessible methods to observe and capture building data in real actual time with the possibility to be combined with machine learning techniques to make forecasting of unsafe climate that is not pleasant such as extreme high heat, indoor humidity and numerous more that lead to respiratory diseases which can be transmitted in various social channels and announcements centre to take appropriate actions to avoid spreading such diseases [7].

According to recent study, smart homes and buildings currently must be monitored to guarantee service quality through the implementation of certain procedures and activities for environmental evaluation and inspection. The Arduino Uno microcontroller and environmental sensors were used in the study in [9] to monitor data in an aging building. The observed data is captured in cloud by the usage of Wi-Fi module [10]. Every few seconds, this data is sent from the base area to the cloud for additional monitoring.

Previous work in [11] offered computational signal processing devices that offers quick feedback on the solar energy in the surrounding environment using sensor-based platforms to enable data collecting. The suggested prototype controllers can monitor the level of hazardous radiation from anywhere in the world when placed [12]. This approach employs a centralized sensor network, which is somewhat less expensive than the conventional portal radiation monitoring.

Without the necessity of person engagement, environmental conditions are recorded by linked sensors [13], where the core notion of recognizing atomic elements is done using Bayesian approach. Maintaining a clean, safe atmosphere with adequate air quality is crucial to reducing the risk of developing meningitis. Thus, this study examined existing IoT-based environmental monitoring solutions in addition to machine learning methods and platforms for increasing public awareness of the risk of meningitis. Additionally, a survey was administered to participants of four different nationalities on their awareness of meningitis and their ability to maintain a comfortable interior temperature. In addition, the study created a prototype technique that gather monitor, and stored environmental data in ThingSpeak IoT cloud platform. The results of the study show that a cloud environment can perform real-time sensor data input. It is interesting that this design used various variables than the previous system, which was easy to maintain and manage online.

The remainder of this study is structured as follows Section 2 provide background of IoT and indoor environmental monitoring Section 3 offers the study material and procedure. Section 4 provide recommended strategy. Section 5 offer experiments and comments, and section 6 end the study. 5 provide experiments and discussion, and section 6 conclude the study.

RELATED WORK

Environmental Monitoring

IoT describes networks of intelligent devices that may connect to the Internet and exchange data with other devices and people [14]. Examples include internet-connected cameras that enable you upload pictures online with a single click, automated home systems that activate your front porch light when you leave work, and wristbands that let your friends know how far you've jogged or biked during the day [15]. At the moment, more than a billion people are

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profiting from IoTs. Billions of dollars are conserved, and fresh perspectives are offered to the people across the world via IoT systems [3]. Examples include self-driving automobiles, better medical equipment, robotic manufacturing, smart grid, and many of the industrial control systems. These systems are frequently provided openly via internet connections that make it simpler to acquire information and data with nearby and propagate it to desired endpoint [16].

In [17], a novel system that observes environmental parameters using a multilayer IOT architecture is proposed. The recommended monitoring employs an II-layer architecture for Internet of Things activities. The system is made up of five nodes that sense, each of which is activated by an actuator in the gateway or a webpage. Data is captured by the sensors and transferred to a slave microprocessor. The slave controller then transmits the acquired data to the main controller [18]. Between those sensor nodes and the data centre, the master functions as a gateway. The data is sent by the master onto the cloud, where it is displayed over HTTP as a website [19]. Another kind of temperature logger used by responsive IoT room environment monitoring systems monitors the temperature in server rooms and displays the current temperature on an online platform via a mobile application and an online server. ThingSpeak is one website that uses an open-source IoT data platform [20]. ThingSpeak featured a device that connected, presented the findings on the ThingSpeak web site, and saved the data as either public or private information. Sample data is gathered for examination in alongside the data saved by ThingSpeak. ThingSpeak offered real-time data collecting and assessment for the web-based text editor [21].

There is growing the amount of IoT application concept in healthcare sector, such as monitoring patients system, cardiovascular and diabetes detection systems patient companion software enable physicians and patient to live and communicate in residence virtually jointly and much more [22]. Study on sensitive data to alert individuals to abrupt changes in the environment that might jeopardize our lives is lacking, nevertheless. To the best of our comprehension, this study has not been conducted out in Nigeria or other Sub-Saharan African nation that are prone to Meningitis. Our purpose is to give preventative measure by alerting everyone about the harm that harmful climate may do so that individuals will be mindful of the threat and take all required action that might prolong their lives, and we view IoT technology idea as an option toward that goal.

To ensure that people were spending more time at work, at home, in a business, or anywhere else they were working in their free time, the articles of [2, 3] continued to concentrate on the environment. The gadget may be accessed from afar and operated via the Internet of Things. It gathers data initially utilizing a range of sensors, then communicates the sensor findings to cloud. A brief survey is done concerning the utilization of cloud and internet of things, wireless sensor technologies, and the connection of sensor-equipped devices. The sensor value is read by the network connection and may be later monitored online. The surroundings is continuously tracked via a website and is handled both manually and automatically by detecting the sensor data. The basic purpose of a cloud storage system is data processing and storage. The Internet of Things enables physical items to behave intelligently and collaborate to make choices that are helpful for many applications. After actively coming to their own views, they collaborate and discuss issues to reach a single, difficult decision. Computers, integrated sensors, interaction protocols, and network protocols are examples of internet of things (IoT) technology. Communication report phrases enable the provision of significant applications that pose several challenges and new requirements that require specialist [23].

The authors of [24] described a sensor system to analyze the surrounding setting, which measures the temperature and humidity. Activities like wireless heating and cooling controls can be triggered by sensing data. The customers obtain the data identified by an android software after it has been retrieved from the cloud. Thingspeak gets the data for analysis and storage. The installation and consequences of a climate

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tracking system that employs sensors to assess the nearby area's climate and humidity have been presented in [25].

IoT solutions are designed to monitor the critical physical processes that generate the data that is sent and stored in the cloud. From there, it may be accessible by a number of apps to carry out further tasks. This information could be applied to initiate certain short processes, such remotely controlled. A setting monitoring system based on real-time IOT and cloud services is examined in the study in [21]. The system keeps an eye on and regulates critical environmental elements including temperature, humidity, and carbon monoxide before sending the data to the cloud. The end user has access to this discovered data in the form of statistics graphs. The different elements, such as the Arduino, digital temperature and humidity sensor, Wi-Fi module, and data queue monitoring transit. The approach proposed in [22] allows people to obtain ecological and spatial data. In order to improve communication, this study proposes an inexpensive ecological monitoring network that makes use of free technologies and the internet of things. This gadget can track temperature, humidity, UV radiation, noise, particulate matter, and carbon monoxide levels. The information is acquired by the network using a number of sensors, then saved in its database before being presented on the Apache local web server.

In order to determine energy consumption, the researchers of [23] presented a technique that looks at and analyzes environmental parameters using an embedded system. In order to lessen air pollution, a variety of modern technologies have developed many techniques to assess and monitor ecological factors. A scenario like this may be built by integrating the internet of things with a wireless sensor network. If the web application is handled effectively, the data may be obtained. The system can provide the many environmental areas where various human behaviors might be extremely harmful. Furthermore, this technology may be used in many sorts of buildings where human interaction is limited.

According to [25], a wireless sensor system solution for environmental observation has been presented. A climate observation system may be constructed using a microcontroller board equipped with temperature, humidity, and vapor sensors. To increase the accuracy for the surroundings, the sensors can also be modified. With the Raspberry Pi, a wireless network may be set up fast and easily as a Wi-Fi module. To examine the platform based on environmental monitoring, an ecological assessment system has been designed. The urban environment needs effective regulation to conserve energy and increase air quality without sacrificing occupant behavior, according to a study in [26]. In expecting this, scientists advise remote monitoring of air quality, temperature, and humidity parameters in contaminated region. Android application was utilized to deliver statistical data to LabVIEW. This data would be utilized to apply pollution control and limit the prospective fuels generation. Additionally, a lab experiment was conducted in which the sink node was placed in a different room and the sensor and router nodes were placed in the same room, separated by walls, to simulate a real-world setting like a building. Although the suggested system was not compared with any existing system, nonetheless, the experimental analysis reveals promising outcomes.

[27] claim that retrofitting approach in both rural and urban building often leads to airtightness and the results are bad circumstances for the inhabitants that might jeopardize our health or perhaps cause disease. To solve this difficulty the author presented a toolkit for effective indoor air quality and temperature control. The solution combines ad-hoc sensors for the monitoring of Total Volatile Organic Components (TVOC), CO2 and thermal comfort coupled with a control logic that, using measured data, gives the appropriate rules to activate the control of HVAC system.

The study in [28] highlights the significance of reliable and effective temperature and power monitoring in crucial areas including the operating room, pharmacy, and intensive care unit. Furthermore, study attempt to provide technique to continually transferring temperature and humidity data via wireless sensor network to

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internet of things gateway and saved in cloud server for data analytic to create different sort of report. This report may be employed to optimize power usage and also be utilized by concerned medical staffs for the purpose of a real-time inquiry and control on the environmental data by connecting their intelligent terminals (such as cell phone) to the server. With consistently accurate data collection and dependable control, the experimental assessment produced intriguing results.

Three perception layer architectures were suggested in [19] to monitor interior temperature and humidity and control energy use without sacrificing occupant behavior. The suggested layers have sensors at the top that collect data about the living conditions of the occupants, a fuzzy-based set of rules in the middle that govern how the system makes decisions based on collected temperature and humidity, and a nZEB prototype at the bottom that provides data among the nodes that would share updates with the cloud server.

[19] examined how the internet of things may affect energy conservation and human thermal comfort in the context of smart homes and buildings. This can be accomplished by automating the building itself using sensors that track occupants' reactions to certain temperature levels and monitor energy use. In order to maximize energy usage, the gathered data would thereafter be used to electrical appliances that are in charge of preserving the thermal comfort conditions (lighting, temperature, and air quality). The results of test bed assessments show that the suggested solution can manage heterogeneous devices and is crucial for flexibility and interoperability across IoT platforms.

Indoor health challenges

In attempts to suppress epidemics of cerebrospinal meningitis (CSM), a lot of meningococcal vaccinations were organized and delivered. This vaccine was first tested in Africa in Sudan in 1915 [6]. The general effect of such trial was horrible or inconclusive. Even still, the vaccination occasionally seemed to observe inoculation. Shortly after that specialized immunization for meningitis illnesses went into recommended as an it was offered as a research proposal to be financed by World health Organization (WHO) [29]. Consequently, in 1964 successful whole-cellu vaccine was produced by researchers at Institute Merieux, Lyon, France, and in 1965 [30]. Recently after, another vaccination enzyme-lysed was also made by study team at Hygiene Laboratory in department of national Health and Welfare of Canada [31].

The purpose was to explore if infection can be protective under epidemic situations. The investigation was conducted at seasonal peak instances; controlled field experiments were held in the Sudan early in 1973. Regarding that, a total of 21,6,40 participants received vaccinations; half received the meningococcal polyoxide vaccine, while the other half received the tetanus toxoid vaccine [32, 33]. Following the immunization during the typical meningitis season, ten instances were recorded in the second half, seven of which were verified by laboratory testing, whereas no cases were reported in the first half. Even Nevertheless, vaccinations are more effective in controlling meningococcal meningitis outbreaks during epidemics. However, many unvaccinated persons may be saved with the aid of effective means of alerting them to the serious risk of meningitis.

Another study conducted by case management site MSF in collaboration with WHO Collaborating Centre for Reference and Research on Meningococci, in Northern part of Nigeria regarding Meningitis outbreak cases from February 10 to June 8, 2015, [2]. The result of the analysis reveals total of 6394 cases 65 confirmed and 6329 probable cases of CSM including 321 deaths were recorded. The outbreak lasted 17 weeks, affecting 1039 villages in 21 local government areas in three states (Kebbi, Niger, Sokoto) with cumulative spread of 282 cases per 100,000 population in the wards affected. This shows despite frequent vaccination program there is need for intervention of Information and Communication Technological solutions as part of prevention measure to reduce spread of this type of diseases.

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An attempt to discover the pattern of cerebrospinal meningitis outbreak in Kebbi State in year 2015 was done by [12] in affected local government (LG) areas with reported death cases [36]. It was shown that many of the suspected case has sudden onset of fever (>38.5 C rectal or 38.0 C axillary) with symptom of altered consciousness, neck stiffness, or other meningitis signs. While in case of toddler with sudden onset of fever (>38.5 C rectal or 38.0 C axillary) and symptom of neck stiffness, or flaccid neck, bulging fontanel, convulsion, or other meningitis signs. The result of the analysis indicates a total of 1,9,92 suspected cases of CSM were seen within the 18 weeks that the outbreak lasted. 1127 (57.0%) were males and 865 (43.0%) were females with a case fatality rate of 4.0%.

Majority of death are those above 15 years of age (31.0%), 1252 (62.9%) of cases were immunized against neisseria meningitides type A [19]. Two-thirds (16) of the LGAs in the state were affected and Aliero LGA had about half (n=1106; 55.5%) of cases seen. Most (77.3%) of samples analysed were positive for Nm type C. In general, each year Kebbi state experienced an outbreak of cerebrospinal Meningitis that result in loss of life especially 15 years of age and above. Therefore, effective environmental measure such as temperature and air quality monitoring system needs to be in place to alert people in order to prevent future occurrence. Another research by [18] was carried out to investigate meningitis outbreak in year 2009 despite massive vaccination campaign which result high mortality among children.

The study considered 16 States in Northern part of Nigeria, involving 48 LGs, 91 health facilities, and 96 communities. In depth interview were conducted with key informant from various sectors such as federal to the community level, a review of records, and a solution-oriented national workshop with participants from all States of the Federation [37]. Collected samples of Cerebrospinal fluid (CSF) from some of the suspected cases at the start of the outbreak were analyzed. The investigation reveals Kastina (11153, 20.4%), Jigawa (8643, 15.8%), Bauchi (8463, 15.5%), Kano (6811, 12.4%), and Gombe (6110, 11.2%) were the States with the highest prevalence of meningitis. Nasarawa (11.0%), Adamawa (8.0%), and Borno (7.6%) States recorded the highest percentage of deaths, while the Gombe (12.5%), Sokoto (9.8%), and Kaduna (9.1%) States recorded the most deaths amongst children.

MATERIAL AND METHODS

This section explains the approach used and how it was carried out to address the study objectives. The research focuses on two elements in this portion: theoretical and practical. First, the theoretical component was examined through a survey of pertinent literature on the use of the Internet of Things for climate monitoring and current indoor health issues worldwide. Secondly, the practical part incorporates field surveys and empirical experiment settings. A random sample approach was utilized for the study; the participants are individuals with an age range from eighteen to sixty years. This permits to inclusion of in-person interviews with individuals about their experiences with meningitis-related data in various indoor temperature circumstances, using the questionnaire that has been prepared. The seven-point ISO 77300 scale (very hot, hot, warm, neutral, cool, cold, and extremely cold) was used in the study to capture subjective elements and views in answer to the question, "How are you feeling now?" A Rayman software was used to compute PET. In addition, an IoT prototype was built based on participants' data to notify individuals about the danger of inadequate indoor conditions that might result in different ailments, notably meningitis

Data Collection

The quantitative data collecting technique is extensively utilized in data gathering and analysis as mentioned in [9]. In a similar vein, this study used a comparable research methodology for participant data collecting and analysis. The question utilized in this research was borrowed from a study of [44] where they aim to assess indoor environmental quality based on seven-point ISO 77300 scale. Using ISO 8996 as a basis, the questionnaire was created for

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participants of various nationalities (Niger, Nigeria, Saudi Arabia, and Malaysia), as shown in Table 1. The study further categorizes participant according to the state of nationality even though, some nationalities share identical weather condition through year. Most statistical approaches for surveys agree that a minimum of total 100 participants are needed for a survey whereas this study target 2000 participants. It is vital to highlight that ethic approval was acquired by Kebbi State University of Science and Technology, Monash University Malaysia, and Kingdom of Saudi Arabia Ministry of Education University of Hail. Subsequently, an informed permission was acquired from all subjects participated in this research. Google Form was used to create the survey, which was then disseminated via several channels.

Table 1: Participating Nation

S/N	Country	Sample Size 100 (minimum)
1	Nigeria	373
2	Niger	257
3	Saudi Arabia	130
4	Malaysia	215

Measures

Meningitis related data

To gauge the degree of use of traditional announcements, the questions were arranged according to the three explained things. Each participant must use a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5), to indicate how much they agree or disagree with the statements pertaining to indoor environmental data, as indicated in Table 2.

Table 2. Measurement scale

Scale	1	2	3	4	5
Measurement	Disagree	Disagree	Neutral	Agree	Strongly agree

Indoor temperature preferences

Using transient thermal equations [38], based on predicted mean vote (PMV) on an eleven-point thermal sensation scale, the PMV index is employed (see to Figure 1). This is necessary to provide the participants the freedom to provide their opinion temperature preferences.

-5	-4	-3	-2	-1	0	1	2		4	5
Extreme cold	Very cold	Cold	Cool	Slightly cool	Neutral	Slightly warm	Warm	Hot	Very hot	Extreme hot

Figure 1: PMV index for ASHRAE 55 and ISO 7730 eleven-point thermal sensation

More than 750 participants shown an interest to participate in the study survey. The expected time to complete the questionnaire is estimated to be 20 minutes. Figure 2 shows the Research Survey Design model used in the study.

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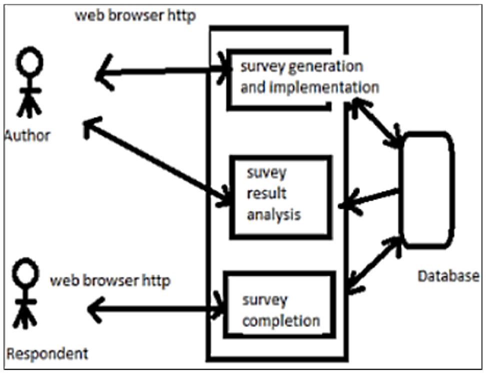

Figure 2. Research Survey Design Model

The questionnaire was distributed to the participants. In order to get comments from a wide range of backgrounds, participants were recruited at random and their input was organized by nationality. This method yielded a variety of perspectives on the subject at hand. Approximately 753 individuals indicated interest in participating in the study after being asked by email. Involvement in the study is fully elective, and participants may withdraw at any moment. The study also assures participant confidentiality. The completion of the questionnaire was viewed as a sign that the participants were willing to take part in the study.

As part of the data collecting process, the survey was digitalized and distributed via internet sites that serve the demographic sample in the form of a Google form. A variety of research completed in similar domains were considered to develop the survey. According to [38-40] different study and confirmed using a Cronbach alpha of 0.7. Pie charts and basic bar charts were used to assess the different data.

Pilot research was conducted out to exclude questions that would not lead to adequate replies in the study, and construct with less than 0.7 Cronbach alpha were redressed. As in other studies [38–40], the data collecting questionnaire only included constructs with a score of 0.7 or above. After evaluating the data, a total number of 48 were eliminated as some did not answer all the questions presented. Out of the 753 surveys that were received, 705 were legitimate and completed.

Data Analysis

This section explains the demographic information of participants in the survey (see Figure 3). The groups are classified into six categories. The first group fall between 18 – 23 ages with 12% i.e 85 participants. The second age group fall between 24-29, is 24.8% i.e.175 participants, the third age group fall between 29-33 with 29.36% i.e. 207 participants, forth age group fall between 34-38, with 16.31% i.e 115, the fifth age group fall between 39-43, is 9.2% i.e 65, and lastly, the age group between 44 and above is 8.2 %, which are 58 respondents. Moreover, the number of participants based on gender shows, males constitute 6% and females constitute 22.9%.

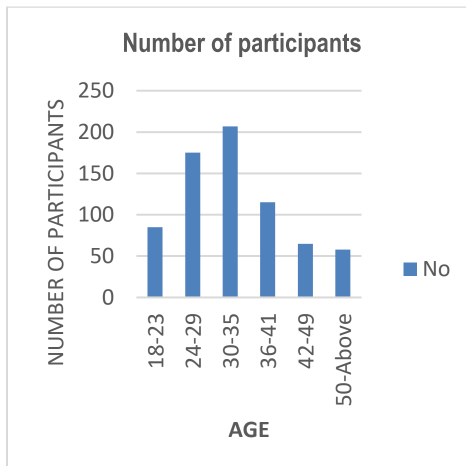

Figure 3. Demographic Analysis

Nationality Analysis

This section highlight the respondent's nationality analysis presented in the Figure 3. This analysis provide a hint on how serious a particular nationality are on participating in the solution to reach out as many people possible to avoid the health issues related to Meningitis.

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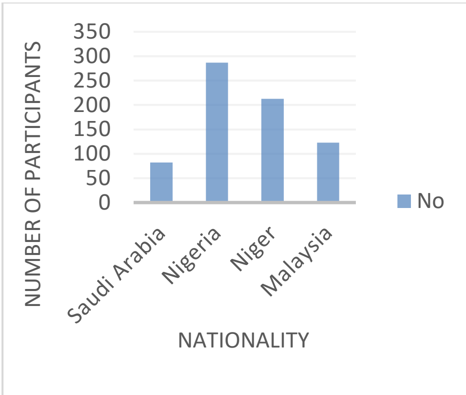

Figure 4: Participants' Nationality Analysis

The Figure 4 shows majority of the respondents are from Nigeria, and Niger with percentage of 40.7% (287 participants out of 705) and 30.2% (213 participants out of 705) respectively. The Saudi Arabia has the lowest number of participants with only 11.7% (82 participants out of 705). While Malaysian nationality moderately response to the survey with 123 participants making 17.4%

Medium of Communication Analysis

This section shows the various medium of communication used by the participant in getting important information. Based on the feedback received, there are six major medium of communication utilized by participants on receiving an important announcement or information as shown in Figure 5.

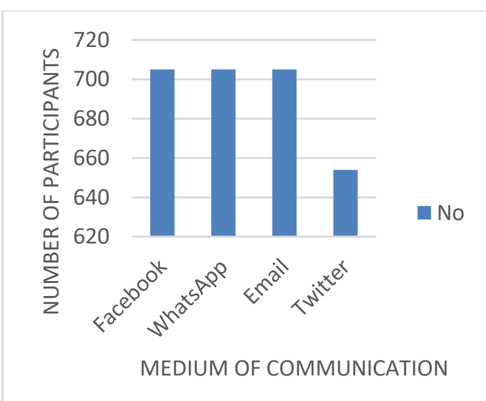

Figure 5 Responders' Medium of Communications

The Figure 5 indicates all participants used Facebook, WhatsApp, and Email for getting an important update regarding the participating on the survey. While few of the participants indicate lack of interest to engage survey via twitter platform.

RESULT ANALYSIS

Survey Response on participant awareness on meningitis

Under this subject, the survey questionnaire was divided into six sub questions (Q1, Q2, Q3, Q4, Q5 and Q6) as shown in Figure 6 to analyze the knowledge and understanding of the participant on the meningitis.

Q1 what is meningitis and its danger.

With regard to knowledge of what meningitis and its danger is. The participants, 60.2% (425 participants out of 705) agreed on being aware of meningitis and its danger is. 29.4% (207 out of 705) strongly agreed with the answer given. At the same time 9.5% (67 out of 705) indicates neutral, 0.9% (6 participants out of 705) disagreed while none of the participants strongly disagreed (see Figure 6).

Q2: The impact of indoor air quality on meningitis

Regarding the having knowledge of participant on air quality level that might result in meningitis sickness is within an indoor environment allows to participant to raise awareness to their relative, friends and family within and even outside of their community. Only 18.3% (129 participants out of 705) of the respondents agreed about knowing what causes meningitis sickness, 15.9 % (112participants out of 705) agreed. 29.3% (207 participants out of 705) of the respondents remain neutral, 19.6 % disagree (138 participants out of 320) and 16.7 % (119 participants out of 705) strongly disagree, (see Figure 6).

Q3: The symptoms of meningitis sickness

With regards to whether participants have knowledge of meningitis sickness enhance

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quicker response to tackle the sickness as quick as possible. 47.8 % (337 participant out of 705) of the participants strongly agreed that they are aware of early symptoms of meningitis and 44.7% (315 participant out of 705) agreed. 6.5% (46 participants out of 705) reported neutral and 0.99% disagreed (7 participants out of 705). No respondents strongly disagreed with this, (see Figure 6).

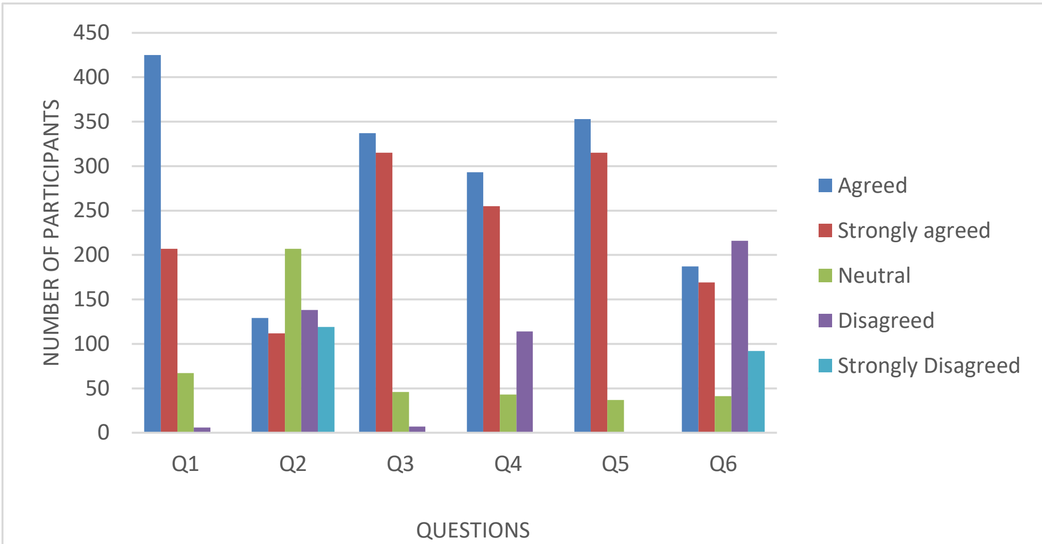

Figure 6: Participants response on meningitis symptoms

Q4 availability of ventilation equipment

The availability of ventilation equipment is one of the concerned reported by participants, 41.5 %, (293 participants out of 705) and 36.2 % (255 out of 705) strongly agreed of having ventilation equipment in the building and agreed respectively, 12.2% (43 participants out of 705) remained neutral while 16.1% (114 participants out of 705) disagreed. No respondents strongly disagreed, (see Figure 6).

Q5 Availability of ventilation opening in the building environment

Concerning if participant has various option for cross ventilation, the response indicates 50% (353 participants out of 705) strongly agreed that they have several opening options for cross ventilation and 44.6% (315 participants out of 705) agreed; 5.2% (37 participants out of 705) were neutral with no participants disagreed or strongly disagreed, (see Figure 6).

Q6: social media is an easier source of information and knowledge sharing.

The result analysis represented in the Figure 5 show the respondent's perspective on knowledge and understanding of social media shows, 38.4% (187 participants out of 705) of the respondents strongly agreed that the social media enables the sharing of knowledge as quickly as possible and 53% (169 participants out of 705) agreed with this. 5.8% (41 participants out of 705) were neutral and 2.8% (216 participants out of 705) disagreed and (92 participants out of 705) strongly disagreed with this concept, (see Figure 6). This indicates there is a need for more emphasis and awareness program that will discuss it important.

Survey response on participant on satisfactory indoor temperature

The technique for measuring the indoor temperature in the study is based on the methodology from [2]. The logging devices rests

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securely in the centre of the room to avoid exposure or discharges from walls. In order to assemble the sensors on top of one another, data loggers additionally mounted on sidewalls and poles. To keep the device from dropping, the data logger was secured with sticky tape at a height of two meters on a pillar or wall. To minimize the impact of solar radiation or cold from outside in order to have precise readings, a data logger is placed far enough away vents and roofs (see Figure 8).

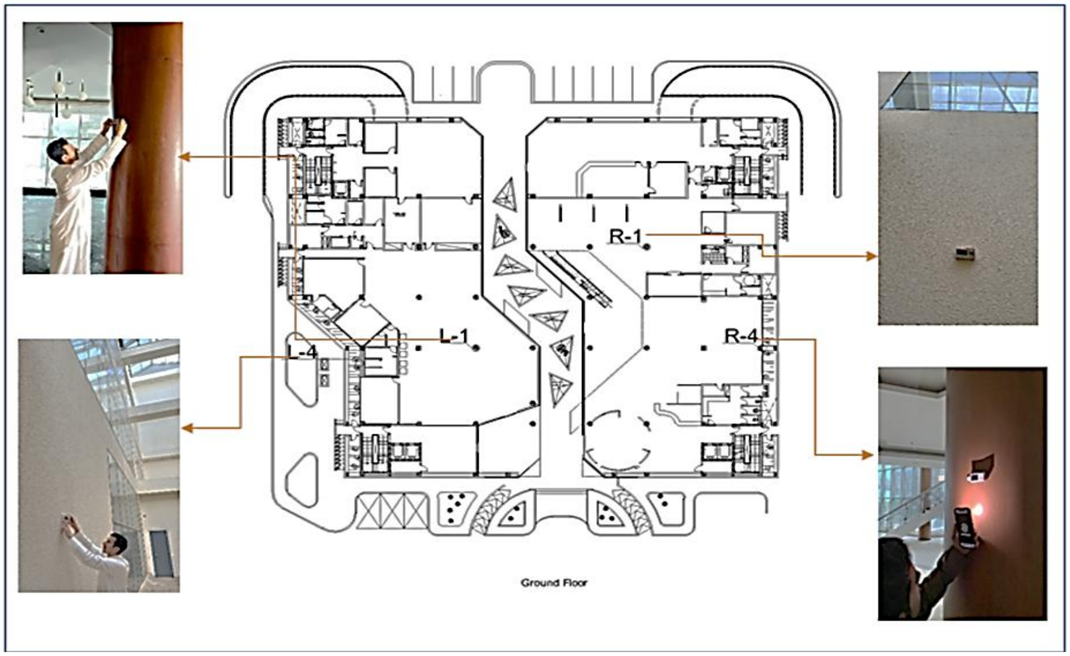

Figure 7. Installation of sensors for indoor temperature measurement

Only 705 of the responses submitted over the course of the research were accepted. The average PET readings for the individuals from Nigeria, Niger, Saudi Arabia, and Niger are displayed in Table 3.

Table 3 PET values for all participant

Nationality	**PET, (°C)**			
	Maximum	**Medium**	**Minimum**	**Amplitude**
Nigeria	41	25	12	29
Niger	56	30	12	44
Saudi Arabia	40	26	12	28
Malaysia	52	28	12	24

Figure 8 demonstrates that a higher percentage of participants in Niger and Nigeria believe the weather is hot when temperature is between range of 27°C - 30°C and 31°C -33°C in the PET while (50%) believe the temperature is very hot (see Figure 8). This indicates that Nigerian and Nigerien appear to have a higher tolerance for hot and lower PET readings. The majority of the nationalities report similar feeling at same temperatures with slight declined in

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Malaysian Nationality (see Figure 9). This indicates that temperature above 43°C is likely to result in meningitis health problem. Furthermore, thermal perceptions of the temperature are quite comparable in the 39°C–42°C PET range for all nationalities indicating weather is extremely hot when PET levels are above 43°C.

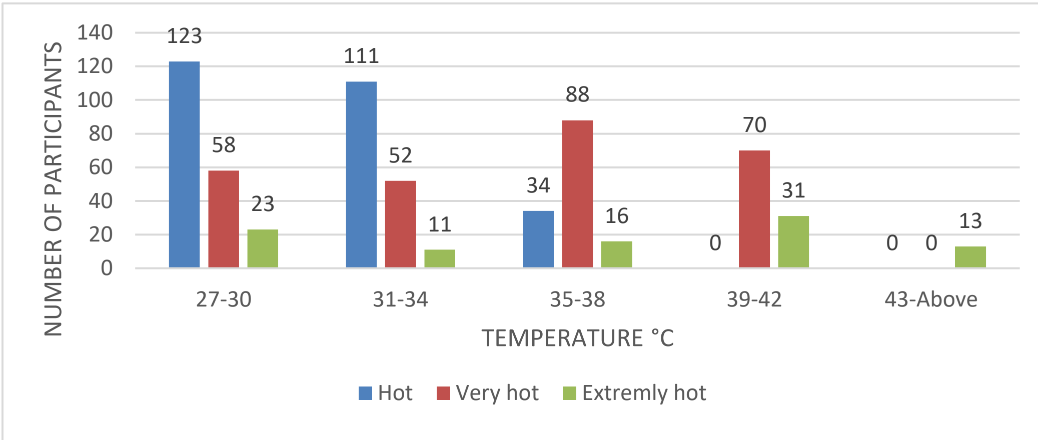

Figure 8. Thermal perception of Nigeria and Niger participants

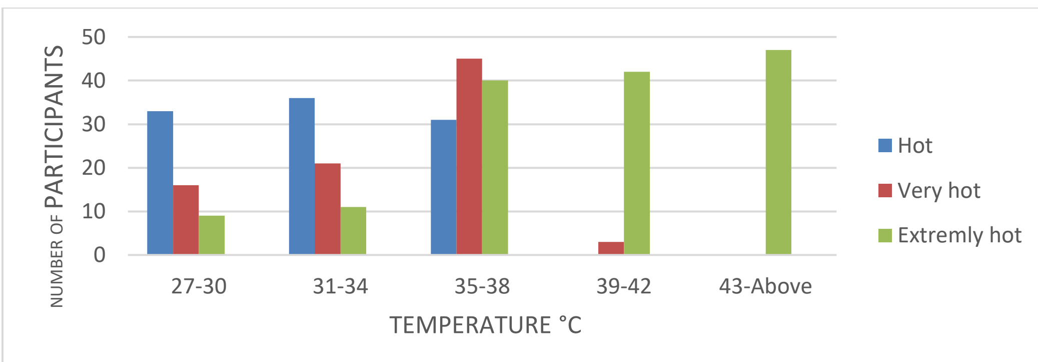

Figure 9. Thermal perception of Saudi Arabian and Malaysian participants

In addition, when the PET index was calibrated based on the conclusions of the logistic ordinal regression which demonstrated the range correlation of the various thermal sensations of the participants. This conclusion tells that, once temperature levels fall very low the PET values become "Very Cold" range could not be assigned to any nationalities. The "Cold" range's top bound is the same for all nationalities. However, the Nigerian has a narrower "Cool" range than Saudi Arabians, while the Malaysians and Indonesians have a broader "Neutral" range. It was difficult to pinpoint the "Warm" range for Malaysians or Indonesians however all the participants experienced the same phenomenon, suggesting feeling "Hot "and "Very hot" as the temperature rises.

Proposed approach

The prototype used controller that served as the core networking hub, and IoTs advancements made it possible for its sensors to gather data. The Arduino controllers are chosen because they facilitate easier advancement, particularly for small-scale IoT research projects [6]. The software component comes in second,

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while the physical programme comes in first. The component that allows code to be uploaded from a computer onto the Arduino board is its second and most crucial component. Because Arduino has a USB interface, it can finish uploading code without the assistance of other components. As long as the internet is connected, this designed system will continuously providing current building data on cloud IoT server (see Figure 10).

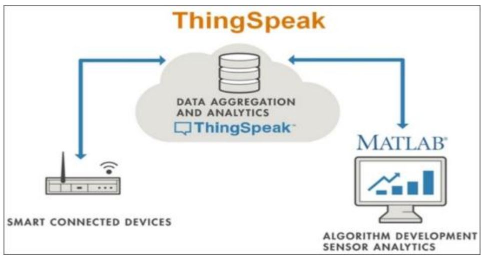

Figure 10. Configuration of proposed approach

As demonstrated in Figure 10 [40], ThingSpeak is a cloud-based IoT platform that enables users to gather, examine, and analyse data in real-time from a range of sensors and devices. Its characteristics, which include real-time data visualisation and analysis, connection to a large range of hardware and software platforms, and interaction with other cloud services, make it a great platform for Internet of Things applications. One of ThingSpeak's key benefits is how easy it is to use. Users can employ a range of connectivity options, such as Wi-Fi, Ethernet, and cellular, to fast and simply connect their devices and sensors to the platform.

After joining, users may create custom dashboards with gauges, charts, and graphs to view and analyze their data. They can also monitor their data in real-time. Along with real-time monitoring and visualization, ThingSpeak provides a range of data analysis capabilities to assist customers comprehend their data. One of the most prominent software platforms for engineering and scientific computing is MATLAB/Simulink, which can be used to undertake comprehensive data analysis and develop bespoke computations and alerts.

It may be used, for instance, to measure water consumption and soil moisture levels in a farm or to monitor temperature, humidity, and air quality in a building. Security cameras, lighting controls, and thermostats are just a few of the smart home products that it may be used to monitor and manage. All things considered, ThingSpeak is a robust and flexible Internet of Things platform with an abundance of features and capabilities. It is the greatest alternative for a range of Internet of Things applications owing to its simplicity of use, real-time monitoring and visualization, and excellent data analysis features. We utilized ThingSpeak to provide reference values for the goal temperature and to monitor the temperature in each room of the simulated house. MATLAB/Simulink and ThingSpeak were connected through the use of Simulink's Real-Time Toolbox.

Experiments and Discussion

At the start of experiments, the sensors are calibrated with the initial temperature at 5°C and fluctuates between -1°C and 11°C, accurately mimicking real-world indoor conditions. The desired home temperature range is between 5°C and 30°C, when the indoor temperature falls below the lower temperature threshold. The room is equipped with a radiator to provide optimal heating efficiency. The temperature of each room is accurately measured and recorded using the Thingspeak interface. This innovative tool allows for real-time monitoring of temperature fluctuations in each room, enabling precise and efficient management of indoor conditions. The data obtained through the Thingspeak interface is critical in optimizing heating efficiency and minimizing energy waste. The temperature readings for each room are presented in the Figure 13, providing users with a comprehensive and detailed view of indoor temperature fluctuations.

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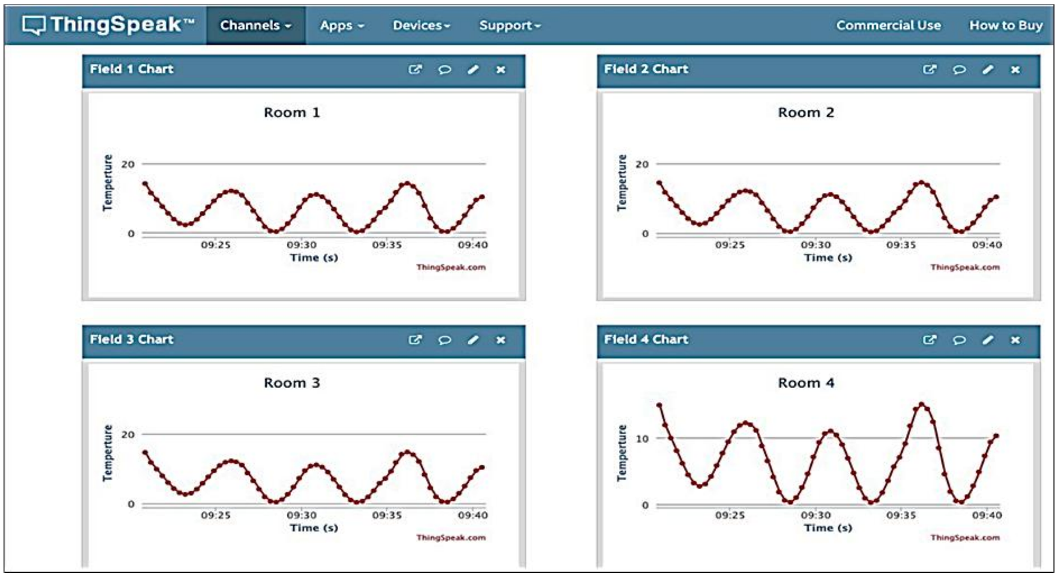

Figure 11: Environmental data recorded in Thingspeak

CONCLUSION

Numerous causes of pollution may be found within places, and in recent years, the relevance of health concerns associated to low indoor air quality has grown. Furthermore, it indicates that the health impact of interior air pollutants concentration is significantly larger than that of outdoor pollutants. In fact, one of the most serious five environmental risks to public health are indoor air pollution. The etiopathogenesis of many non-specific symptoms and clinical manifestations that characterize sickle cell disease has been shown to be influenced by indoor air quality. Numerous symptoms in the skin, eyes, neurological system, and upper and lower respiratory tract might be brought on by this disease.

Currently studies apply ventilation to manage indoor air quality and provide thermally comfortable condition by modifying air temperature, airborne chemical, and relative humidity. When evaluating the airflow pattern and the migration of contaminating particles inside occupancy areas, numerical solutions perform effectively. As a result, various researchers have utilized numerical models to explore how airflow and pollutant concentrations behave. In order to monitor indoor air quality, this study used indoor environmental sensing with a low-cost smart sensor that was built using an Arduino board, XBee modules, microsensors, and machine learning. The solution allows real-time monitoring data to be stored and made available on a ThingSpeak. It is possible to add extra sensors to identify certain pollutants. The findings suggest that the system is capable of giving an effective indoor air quality evaluation to limit the risk of exposure. In practice, the indoor air quality might differ substantially from what is typical of a high-quality living area. Such devices would be advantageous as public health remedies to minimize the burden of infections and symptoms connected with sick buildings like meningitis.

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