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Implementation of Appropriate Technology Used to Continuous Monitoring of Weather Conditions and Air Quality on Gili Iyang Island, Sumenep

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ABSTRACT

This article discusses the implementation of a weather station which also functions to measure gas concentrations in the air. This internet of things (IoT) based real-time telemetry device uses the Arduino Uno WiFi Rev 2 board to process measurement data. Several weather parameters that are measured are wind speed, wind direction, air humidity, ambient air temperature, air pressure, and rainfall. While the gas concentration parameters in the air are oxygen, carbon monoxide, and carbon dioxide levels. The readings from all sensors are processed by the Arduino Uno WiFi Rev 2 board and uploaded to the server. Then the client device will receive a collection of data to be processed, displayed on the monitor, and stored in the form of a text file. Furthermore, monitors and data are used to analyze air quality and ambient weather conditions. The expected result of this hardware is that it can monitor the weather around it and can be used to reduce the bad risks caused by the weather itself.

KEYWORDS
Monitoring of Weather;
Air Quality;
Internet of Things;
Automation systems;
Sustainable community;
Sustainable development

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1. Introduction

Gili Iyang has the highest oxygen content in Indonesia and the second best in the world after the Dead Sea in Jordan.Thus, Gili Iyang is referred to as the oxygen island. In the local language, "Gili" means island. Gili Iyang covers an area of 9.15 km² with 7,832 people living in two villages, Bangkamala and Banglaas. In 2006, the National Institute of Aeronautics and Space (LAPAN) conducted an air quality study of the island. Of the 17 points tested, Gili Iyang had an oxygen content of 20.9 percent, Lapin said. The small island east of Madura is called Oxygen Island because research shows that Gili Iyang has high oxygen levels. This ratio is better than air conditions in other parts of Indonesia. Normally acceptable oxygen levels to meet respiratory needs range from 19.5% to 22.0% . Oxygen deficiency known as hypoxia occurs when oxygen levels fall below 19.5%. The high oxygen content is due to the influence of air circulation from the sea around the island. In addition, another study found that Gili Iyang has a carbon dioxide level of less than 26.5% and a noise level of only 36.5 decibels. Based on these results, Air Visual, an air quality tracking app, placed Gili Iyang's Air Quality Index (AQI) just one level lower than the oxygen levels in Jordan's Dead Sea. This has resulted in a better quality of life for Gili Iyang residents.

The data was taken in 2006, making the statement that Gili Iyang Island is still called the Oxygen Island questionable. Even though this designation is the most popular tourist attraction on this island. This is coupled with an increase in the number of motorized vehicles owned by residents. According to a survey conducted, every family member has one fueled vehicle. fueled vehicles on the island are usually used for three-wheeled conveyances and two-wheeled motorcycles. There are no cars on the island. The increasing number of motorized vehicles will affect air quality. The declining air quality is caused by pollution from the operation of motorized vehicles. Monoxide gas from the combustion of motorized vehicles will suppress oxygen levels. Therefore, it will be a question of whether Gili Iyang Island is still an oxygen-rich area.

Oxygen monitoring used in community service referrals has been studied by previous researchers. The UK's national home oxygen monitoring program for COVID-19 was successfully researched by Weber [1]. A Surface Plasmon-Coupled Dual Emission Platform for Ultrafast Oxygen Monitoring after SARS-CoV-2 Infection was investigated by Rai [2]. A no-consumption Clark-type microsensor for oxygen monitoring in cell culture and organ-on-chip systems was investigated by Liebisch [3]. A time-completed prototype of a compact laser spectroscopy sensor head for respiratory oxygen monitoring was investigated by Patrick [4]. The outcomes associated with brain tissue oxygen monitoring in patients with severe traumatic brain injury undergoing intracranial pressure monitoring were investigated by Hoffman [5]. Doxy: Dissolved Oxygen Monitoring was researched by Shaghaghi [6]. Home oxygen monitoring and therapy: learning from the pandemic research by Beaney [7]. Mitochondrial oxygen monitoring with COMET: verification of calibration in humans and comparison with vascular occlusion tests in healthy volunteers studied by Ubbink [8]. The use of end-tidal oxygen monitoring by emergency physicians for rapid sequence intubation was investigated by Oliver [9].

The chemical flow monitoring system for oxygen level ppm and efficient degassing was investigated by Baronas [10]. Mitochondrial oxygen monitoring with COMET: verification of calibration in humans and comparison with vascular occlusion tests in healthy volunteers studied by Ubbink [8]. Mitochondrial Oxygen Monitoring During Congenital Diaphragm Hernia or Esophageal Atresia Repair Surgery: A Feasibility Study investigated by Costerus [11]. Baronas Reactivity cerebrovascular pressure and brain tissue oxygen monitoring provides. Complementary information regarding the lower and upper limits of cerebral blood flow control in traumatic brain injury: a Canadian High Resolution-TBI (CAHR-TBI) cohort study investigated by Gomez [12]. The method used for the NSW Micromegas Detector Monitoring Gas Suffocation and Oxygen Percentage Test from the LHC-ATLAS Experiment was investigated by Alexopoulos [13]. The development of the Clark Microsensor for Low Concentration Dissolved Oxygen Monitoring was investigated by Nosrati [14]. Activated platinum(II) complex AIE single bonds achieving rapid oxygen monitoring and high-efficiency identification of felodipine were investigated by Di [15]. Oxygen Monitoring Guards were investigated by Kumar G [16]. Status of Oxygen Monitoring in Four Selected Special Care Newborn Units in India was investigated by Sabherwal [17].

Urine Oxygen Monitoring in Cardiac Surgery: Reply to research by Silverton [18]. Embedded Wireless Dissolved Oxygen Monitoring Based on Internet of Things Platform was researched by Boonsong [19]. TRANSCUTANEOUS OXYGEN MONITORING IN THE LOUISIANA PINUS SNAKE (PITUOPHIS RUTHVENI) was studied by Cushing [20]. Home Oxygen Monitoring in Patients with Interstitial Lung Disease was studied by Cardeñosa [21]. Noninvasive Urinary Oxygen Monitoring and Risk of Acute Kidney Injury in Cardiac Surgery was studied by Silverton [22]. Oxygen Monitoring in Model Solutions and In Vivo in Mice During Proton Irradiation at Conventional and FLASH Dosing Levels was investigated by Van Slyke [23]. A Scalable and Cost-Effective IoT-Based Medical Oxygen Monitoring System for Resource-Constrained Hospital Environments was researched by Rodrigues [24]. A flexible thread-based electrochemical sensor for oxygen monitoring was investigated by Xia [25]. Urine Oxygen Monitoring in Cardiac Surgery: Comments researched by Chen [26].

Miniature Prototype for Continuous Noninvasive Transcutaneous Oxygen Monitoring studied by Kahraman [27] Use of Direct Intracranial Pressure and Brain Tissue Oxygen Monitoring in Perioperative Management of Patients with Moyamoya Disease studied by Kommer [28]. The large spatiotemporal variability in metabolic regimes for urban stream drains of four wastewater treatment plants with implications for dissolved oxygen monitoring was investigated by Ledford [29]. A soil microbial fuel cell based biosensor for monitoring dissolved oxygen in water was investigated by Olias [30].

Thus, it is necessary to hold an activity that can map the potential air quality in Gili Iyang. This is important to do to educate the local community to preserve nature and the influence of air pollution from motorized vehicles. In line with previous community service packaged in the Airlangga Community Development Hub (ACDH) Program. Under the coordination of Dr. Agus Hartanto as the head of ACDH activities in the Sumenep Region in 2022, one of the promotions of pollution reduction efforts has been carried out by using electric bicycles. The following community service activities will continue the ACDH program by mapping the potential of air quality and installing weather monitoring tools and oxygen levels (AirFeel version 3 with oxygen sensor). This activity is also a means to introduce the Electrical Engineering Study Program and the Robotics and Artificial Intelligence Study Program, Faculty of Advanced Technology and Multidiscipline (FTMM) Universitas Airlangga to the wider community, so it is deemed necessary to raise the theme "Mapping and Monitoring by Telemetry for Air Quality Potential on Gili Iyang Island" as a Community Service program in engineering at the Faculty of Advanced Technology and Multidiscipline, Universitas Airlangga.

Fig. 1. Ropet Beach, the coastal area of Gili Iyang Island potential

2. Method

In this Community Service activity, the intended target is the community in the two villages on Gili Iyang Island, namely Banraas and Bancamara. The location of this activity is Sumenep, Madura, East Java. The implementation of this community service activity offers two materials, namely 1) the use of information technology for measuring weather and air quality; and 2) the dissemination of the importance of maintaining the preservation of natural air resources.

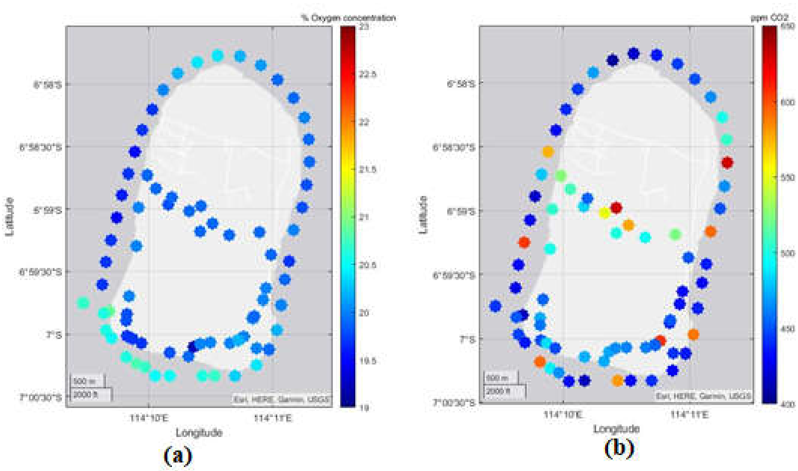

Fig. 2. Visualization of the gases concentration distribution over Gili Iyang Island; (a) oxygen distribution, and (b) carbon dioxide distribution

Installing the AirFeel version 3 system and socializing it was done offline by involving all members of the Implementation Team and attended by 40 participants from the community and village officials. Activities continue to prioritize the COVID-19 Protocol, such as using masks, face shields, and hand sanitizers provided by the Implementation Team, and keeping a safe distance. The room provided for the training can accommodate approximately 50 participants. Most of the time the activities are planned to be held outdoors, more precisely on Gili Iyang Island, Sumenep, Madura.

In addition to the AirFeel version 3 installation activity, a re-survey of area mapping and mapping of the distribution of oxygen and carbon dioxide levels will also be carried out. Area mapping will be carried out using the DJI Phantom 4 RTK drone. While the mapping of oxygen and carbon dioxide levels is carried out by actual measurements in the field based on predetermined GPS coordinate points of around 100 points. The results of the two mappings can be used for planning, construction, and development of educational tourism facilities "Oxygen Island" and renewable energy potential. Apart from that, it can also be used by policymakers to strive for the preservation of clean air resources on Gili Iyang Island.

Figure 2 shows the results of the measurement survey on the first visit to Gili Iyang Island. The results of this visualization show that the point that has the highest oxygen content is located on the southwest coast which is brightly colored. The oxygen level at that location was 20.4%. While the location point that has the lowest oxygen level is on the west coast to the center of the island. The average concentration at these locations is 19.5%. This is because the location is a port where many ships dock. Meanwhile, the central part of the island has low oxygen levels because many residential areas and many motorized vehicles are passing by. In this activity, AirFeel will be installed in 2 locations that have the highest and lowest oxygen levels. Thus later to make a comparison of measurement and monitoring data online.

All activities that will be carried out involve several FTMM Universitas Airlangga students. Students will be made into working groups, each with its tasks. 3 tasks require student contribution: carrying out socialization, field surveys, and installing AirFeel devices. It is hoped that this can add to the knowledge and experience of students in the scientific fields they study in college.

3. Results and Discussion

The progress of making the AirFeel version 4 device is currently used as the output and media for this community service activity. AirFeel version 4 is used to monitor weather and air conditions online and in real-time. Figure 3 shows that the design and implementation process has reached the stage where testing the tool and calibrating the tool have been completed and implemented in the field/partners. The progress of the design and manufacture of the device also involved 5 students from Electrical Engineering FTMM. Where the five students participated in the implementation and socialization activities at the community service location. The research results will be described in the form of hardware, software, database server, and calibration testing.

Fig. 3. The process of testing the AirFeel version 4 device involves students

3.1 AirFeel Device System

AirFeel version 3, the weather and air quality (oxygen and carbon dioxide) monitoring system. There are 2 series of sensors accessed by this system, namely weather sensors, oxygen sensors, and carbon dioxide sensors. The weather sensor consists of an anemometer to measure wind speed, a wind vane to measure wind direction, and a rain gauge to measure rainfall. The weather sensors are connected to the weather station module which functions to collect data from the weather sensor and then sends it to the microcontroller board via serial communication. The oxygen sensor circuit consists of a MIX8410 sensor and a series of voltage amplifiers or op-amps. The carbon dioxide sensor circuit uses the MQ-811 sensor and the op-amp voltage amplifier circuit. The microcontroller board uses ESP32 devkit-C which functions to collect data from all sensors, process it, then send it to cloud storage in the form of a string dataset.

(A) (B)

Fig. 4. AirFeel device version 3 with oxygen sensor customization, (a) device 5 was installed in the east side of the island, Ropet Beach, (b) device 7 was installed in the west side of the island, Samirun Beach.

The AirFeel device that has been assembled in Figure 4, is the process of sending data to cloud storage using a mobile wi-fi modem connected to the internet. The designated cloud storage is a Google Firebase account. The stored data can be accessed by an Android-based application with the same name, namely AirFeel Monitor[8]. Thus measurement data can be monitored in actual and real-time remotely via telemetry[9]. This makes it easier for local people and researchers to observe changes in weather and air quality on Gili Iyang Island.

3.2 Airfeel Monitor Android Application

Monitoring software is created with Android Studio software. The application used for monitoring the results of AirFeel version 4 sensor readings in the field has been published on the Play Store. Android-based applications can be installed by everyone, but require special access. This special access can only be obtained by researchers and partners. To get access to use the application, the user must contact the admin for email registration.

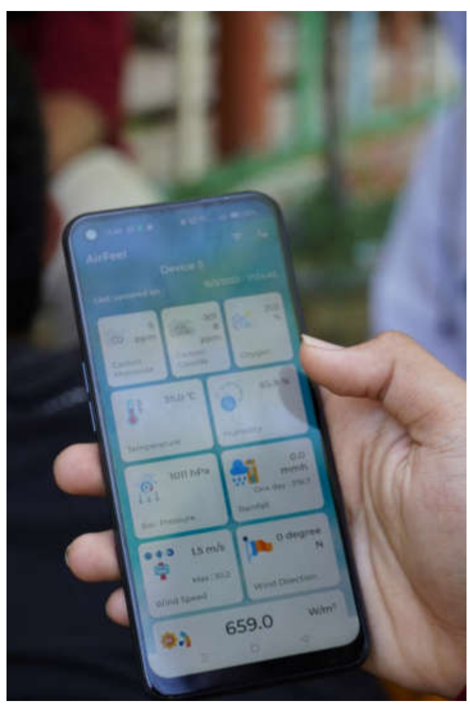

Fig. 5. Display the main menu of the AirFeel application

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Figure 5 shows the menu display used for monitoring air and weather conditions at the location where the AirFeel 5 device is installed. The weather conditions measured are wind speed, wind direction, rainfall, air temperature, humidity, and solar irradiation level. Meanwhile, the air condition parameters measured were oxygen, carbon dioxide, and carbon monoxide. In addition, there is also a menu that is used to find out the date and time of updating the data as well as the position of the device on Google Maps.

3.3 Device Installation

The two AirFeel version 4 devices were brought to the community service location on Gili Iyang Island, Sumenep. One device was installed in the Banra'as village area and one device was installed in the Bancamara Village area. The placement of location of the two devices is on the shoreline. This is intended so that data collection can be carried out validly and optimally.

Fig. 6. Location of the both AirFeel device 5 and device 7

Figure 6 shows the two installation locations for AirFeel 5 and AirFeel 7. AirFeel 5 was installed in the Banra'as Village area and AirFeel 7 was installed in the Bancamara Village area.

3.4 Community Empowerment

The implementation of appropriate technology in Community Community Service does not only involve lecturers and students, but also the community.

Fig. 7. Training for operation procedure and maintenance

This activity involved a tourism awareness group (Pokdarwis) led by Mr. Ahyak. The site survey and operation training for the AirFeel device have been carried out together with the local community. The training aimed for local community to be advance in operational and maintenance of the implemented technology. As shown in Figure 10, the community helps in technical and non-technical matters. In technical matters such as making Arsenic device mats, making sensor stands, and device wiring. From a non-technical perspective, the community also helps provide consumption and arranges community service schedules.

3.5 Dissemination of Appropriate Technology AirFeel version 3

Figure 8 shows the FTMM Universitas Airlangga team has completed carrying out the last mission of this community service activity. The last activity is the dissemination of appropriate technology that has been implemented to support the tourism and renewable energy sectors. Weather monitoring device technology and air gas levels, namely AirFeel version 3 has been delivered to the local community. Besides that, training has also been carried out in system operation and maintenance which was attended by working groups of local residents.

Fig. 8. Dissemination ceremony of community service activity

4. Conclusion

This community service activity has been carried out as a collaborative step between FTMM Airlangga University and the Sumenep Regency Government in order to advance tourism potential on Gili Iyang Island. This activity has several main missions, namely the installation of weather monitoring devices and air gas levels, measurement of wind and solar energy potential, as well as training and dissemination of the application of appropriate technology. With the implementation of the activities, it is hoped that the community can increase knowledge in the field of sensor technology and the internet of things, can increase understanding and awareness of local weather conditions and air quality, can be used to determine renewable energy potential, besides that as an effect it can improve the local tourism sector.

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Author Contribution

The activity plan in order to implement of appropriate technology used to continuous monitoring of weather conditions and air quality on Gili Iyang Island, Sumenep.

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Conflict of Interest

The authors declare no conflict of interest.

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