AUTOMATION OF DATA COLLECTION USING IoT FOR ESG REPORTING

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ABSTRACT:

Sustainability reporting is an important aspect of modern business operations, as companies seek to measure and improve their environmental, social, and governance (ESG) performance. The Sustainability Accounting Standards Board (SASB) and the Global Real Estate Sustainability Benchmark (GRESB) are two organizations that provide frameworks for ESG reporting, helping companies to standardize and communicate their sustainability efforts.

Some of the drawbacks of sustainability reporting frameworks are the manual data collection process which leads to a lot of credibility gaps in the report. To remove such ambiguities we can incorporate the power of the IOT network which will automate the process of data collection in real-time and analyzing the sustainability reports which enables the organizations for a quicker implementation of sustainable practices and produce more accurate and timely sustainability reports. To implement this network, a simulation environment that will mimic the architecture of real-life data collection using the Bevywise MQTT broker and the Paho MQTT client library is implemented.

By using the Paho MQTT client library to connect to the Bevywise MQTT broker, companies can collect data on ESG metrics such as energy usage, greenhouse gas emissions, and water consumption. This data can then be stored in cloud databases such as Google Cloud, enabling data analytics and visualization to support sustainability reporting.

Furthermore, the use of MQTT pub-sub messaging enables real-time alerts and notifications when sustainability metrics exceed predefined thresholds. This helps companies to identify and respond to sustainability issues more quickly and effectively.

Overall, the integration of SASB and GRESB for ESG reporting frameworks with Bevywise MQTT and cloud database technologies enables companies to collect and analyze real-time sustainability data, leading to improved ESG performance and reporting.

KEYWORDS: sustainability, ESG, Bevywise MQTT Broker, AWS Cloud.

I. INTRODUCTION

ESG (environmental, social, and governance) reporting is now a critical component of business operations. Businesses must now publicly declare their sustainability initiatives and show that they care about society, the environment, and good corporate governance. As a result, the demand for precise and trustworthy data to support ESG reporting has increased [1][2]. The Internet of Things can be used as a means of ensuring accurate and trustworthy data collecting for ESG reporting (IoT). By using sensors to collect data from numerous sources, including energy consumption, water usage, and waste management, IoT technology can automate the process of data collection [4][6]. Companies may track and monitor their sustainability practices more easily when using this data, which can be uploaded in real-time to a single platform for analysis. For ESG reporting, automation of data collection utilizing IoT technologies can have several advantages. First off, as the data is gathered automatically and in real-time, it can increase the accuracy and reliability of data collecting. Second, it can cut down on the expense and time required for manual data collection, freeing up resources for other ESG reporting components [7]. Finally, it can help businesses pinpoint areas where their sustainability practices need to be strengthened, enabling them to make the necessary adjustments to lessen their impact on the environment [10].

II. LITERATURE REVIEW

The world's population is growing, and technology use has led to an increase in per capita electricity consumption. Thermal power plants provided most of the energy generated in the current environment. resulting from the burning of fossil fuels in adverse climate effects. Homes and companies utilize over 60% of the energy produced worldwide [4]. Sustainability reporting has become an essential component of contemporary business practices, as companies seek to assess and enhance their environmental, social, and governance (ESG) performance. To simplify this process, companies can utilize established frameworks provided by respected organizations such as the

Sustainability Accounting Standards Board (SASB) and the Global Real Estate Sustainability Benchmark (GRESB). These frameworks allow companies to standardize their ESG reporting, making it easier to communicate their sustainability initiatives in a consistent and transparent manner. To promote sustainability, companies can implement a Building Energy Management System (BEMS), which ensures efficient power usage and enhances customer comfort. Smart grids also facilitate the effectiveness, integration, and consumption of smart buildings. Renewable energy sources such as solar, biogas, and wind can serve as excellent alternatives for traditional energy sources in structures. The report also highlights future challenges in this field and explains how IoT technologies are increasing the efficiency of smart buildings.

Transporting data from data producers (sensors, equipment), a traditional and centralized AI technique poses environmental concerns due to resource needs for processing and communication while also compromising privacy [5]. A new approach is being recommended to lower high energy costs by federating learning operations across low-power devices. In this research, a novel methodology is proposed to examine energy and carbon footprints in distributed and federated learning (FL). The methodology evaluates the energy footprints and carbon equivalent emissions for two different systems: fully decentralized consensus-based systems and conventional FL methods. We discuss operational parameters and ideal constraints that support green FL designs and provide the framework for judging their sustainability.

The Internet of Things (IoT) is an important piece of technology that describes a network of real objects that have been fitted with intelligent sensors [6], operating systems, and other heterogeneous devices with the intention of connecting and exchanging data with other hardware and software over the Internet. Physical characteristics including temperature, humidity, air pressure, light intensity, gas contamination, and precipitation can be monitored and made more interactive with the use of various sensors interfaced with microcontrollers like the ATmega328P. For simple management, the sensors can be connected to the ATmega328P microcontroller. It is possible to collect data on many factors and monitor several systems in real-time thanks to this IoT-based solution. This data can be used for real-time data analysis using IoT and microcontrollers.

This study [7] explores the use of open-source technology to develop a low-cost IoT platform for tracking and storing meteorological data in a residential area. The platform can gather data on temperature, humidity, air pressure, and dust particles through IoT-connected devices. The collected data is then sent to a remote virtual private server (VPS), where server software continuously collects and stores it in a database. This study provides a guide for setting up and securing a VPS server and installing an IoT server application that uses the MQTT protocol for message queuing telemetry transport. With the help of Internet of Things (IoT) devices with the appropriate sensors, like the Raspberry Pi Zero W and NodeMCU ESP 8266, the system is intended to monitor environmental conditions in real time. The project demonstrates how a scalable weather station can be built from scratch while resolving privacy and security issues with the finished product. The IoT server program "Things board" was configured to operate on a VPS through the MQTT protocol. Manufacturers of consumer devices have developed new software programs and methods for utilizing important meteorological data that was collected in a neighborhood adjacent to their residences. This opens opportunities for the creation and development of new consumer technology.

Drinking water is scarce everywhere in Bangladesh's coastal region due to its complicated hydrogeological formations. Concerns concerning establishing equitable and inclusive access to clean and inexpensive drinking water for coastal areas may arise due to toxins from industrial sources. For accurate water quality observation, we created a long-lasting, low-cost IoT-based [8] water quality assessment device. a smart sensor interface that can easily generate data for online real-time measurements of water quality parameters after sensing the parameters affecting the water's quality. To gauge the quality of drinking water, it uses a variety of sensor types. These sensors link to Arduino to track metrics related to water quality. To transmit the values, we set up serial communication between the Arduino and NodeMCU, which will show the data online.

An Internet of Things (IoT)-based indoor air quality monitoring platform is built on a web server and the "Smart-Air" air quality sensor. This software tracks indoor air quality everywhere and at any time using cloud computing and the Internet of Things. Smart-Air is an IoT-based device designed to monitor air quality and send real-time data to a web server via LTE. The device consists of a microprocessor, sensors for detecting pollutants, and an LTE modem. To measure air quality, the instrument in the study [9] used sensors to detect the concentration of aerosols, volatile organic compounds (VOC), carbon monoxide (CO), carbon dioxide (CO_2), and temperature humidity.

The Internet of Things (IoT) [10] has been applied in various contemporary monitoring and control projects, including those for homes, factories, and other locations. These devices conduct self-functions without requiring operator interaction, increasing convenience and safety. One critical area where IoT systems can enhance effectiveness and reliability is electrical networks. By monitoring and detecting faults, IoT systems can find the best solutions in a shorter amount of time and monitor network data. The technology in this paper is based on a wireless sensor network (WSN) that monitors and regulates various electrical and environmental factors, such as power usage, weather conditions, humidity, flames, illumination, and the detection of cable cuts in electrical poles. Each sensor is a node connected to a microcontroller board that collects data, which is presented, tracked, and stored in a database on a local server. The website was developed using multiple web programming languages, and a free global domain was used in the system's development. Real-time sensor data is stored in an internet-based database.

III. PROPOSED MODEL

A.The IoT Architecture

In this architecture, environmental, social, and governance (ESG)-related data are gathered via IoT devices. The cloud-based infrastructure is then used to process, store, and report the data that these devices have collected. To be more precise, the data is moved to a cloud database for archiving, processing, and reporting. A cloud platform like Amazon Web Services (AWS), Microsoft Azure, or Google Cloud Platform (GCP) may be used to host this database. Utilizing the MQTT (Message Queuing Telemetry Transport) protocol, the data is published to the cloud database. IoT applications benefit from the efficiency and portability of MQTT. A broker is necessary in order to publish data over MQTT. This design makes use of a Bevy smart MQTT broker. The broker serves as a middleman between the cloud database and the IoT devices.

The Paho MQTT client is used to establish a connection with the Bevy smart MQTT broker and publish data. An open-source client library called Paho MQTT exposes MQTT capability to a variety of hardware and software platforms.

Overall, this design enables IoT devices, cloud-based infrastructure, and the MQTT protocol to automate data collecting for ESG reporting.

1)This model[Fig 1] postulates that automating data collection for IoT-based ESG reporting will result in more precise and timely data collection, lower costs, and better ESG reporting. The usage of the cloud database will provide a centralized location for data storage and analysis, while the use of the Bevywise MQTT broker and Paho MQTT client will ensure that the data is delivered securely and effectively. Companies may streamline their ESG reporting, enhance their environmental and social impact, and boost transparency and accountability to stakeholders by automating the data collection process.

a) The DHT11 humidity sensor and the BMP085 atmospheric pressure sensor can be used to detect temperature with accuracy and dependability. This technique can be applied to a variety of temperature-sensitive applications, including weather monitoring and indoor climate control. The BMP085 sensor is used to measure atmospheric pressure, while the DHT11 sensor is used to measure humidity. The temperature is then derived from these readings using appropriate mathematical formulas or algorithms.The use of these two sensors is advantageous as they can provide multiple parameters, which reduces the need for additional sensors to be interfaced with the IoT microcontroller. However, a newer sensor, the BME280, can provide all three parameters (temperature, humidity, and atmospheric pressure) but is relatively expensive.

B. Hypothesis Development

The first step in this model is to select the IoT devices that will be used for data collection. IoT devices used for ESG reporting should be capable of collecting data on a range of environmental, social, and governance factors. This may include air quality, water quality, energy consumption, waste management, and other relevant metrics. The data collected by these devices can provide companies with valuable insights into their environmental impact, social responsibility, and corporate governance practices, helping them to identify areas for improvement and make informed decisions about sustainability initiatives. The devices should also be compatible with the bevy-wise MQTT broker and Paho MQTT client. The next step is to install the bevy-wise MQTT broker. The broker acts as a communication channel between the IoT devices and the cloud database. It receives data from the devices and stores it in a queue until it is ready to be sent to the cloud database. The Paho MQTT client is then installed on the IoT devices. This client is responsible for publishing the data collected by the devices to the bevy-wise MQTT broker. The client establishes a connection with the broker and publishes the data in a structured format. The cloud database is then set up to receive data from the bevy-wise MQTT broker. The data is stored in the database for further analysis and reporting. The database can be accessed by authorized personnel from anywhere in the world. Finally, the model is tested and optimized for efficiency and accuracy. The data collected from the IoT devices is analyzed to ensure that it is accurate and reliable. Any issues are addressed, and the model is fine-tuned for optimal performance.

IV. METHODOLOGY

To begin, you will need to set up your IoT devices for collecting data related to ESG (Environmental, Social, and Governance) factors. This could involve sensors, cameras, or other devices that can collect and transmit data. Ensure that the devices are properly configured, powered, and connected to the internet.

Once the hardware is set up, the next step is to configure the bevy-wise MQTT broker, which will act as the messaging intermediary between the IoT devices and the cloud database. bevy wise is an MQTT broker that supports a wide range of devices and provides a user-friendly interface for configuration. Paho is an MQTT client library that can be used to publish and subscribe to MQTT messages. You will need to create an MQTT client using Paho, which will be used to publish data from the IoT devices to the bevy-wise MQTT broker. Once the MQTT client is created, you will need to configure it to connect to the bevy-wise MQTT broker. This involves specifying the broker's IP address, port number, and authentication credentials. With the MQTT client configured, you can start publishing data from the IoT devices to the bevy-wise MQTT broker. This process includes two key steps: firstly, defining the specific topic or category that the data will be published under, and secondly, formatting the data in a structured manner that enables easy processing and storage by the cloud database. The data published to the Bevy wise MQTT broker can be securely stored in a cloud-based database, which can include platforms like AWS IoT, Microsoft Azure IoT Hub, or Google Cloud IoT Core. These cloud platforms offer reliable and secure storage solutions for IoT data, enabling companies to store and manage large volumes of data, perform real-time analysis, and gain valuable insights into their ESG performance. This involves configuring the cloud database to receive data from the bevy-wise MQTT broker, mapping the incoming data to the appropriate database schema, and setting up any necessary data pipelines for processing the data.

V. RESULTS, DISCUSSION, AND IMPLICATIONS

1) IoT hardware Implementation

Fig 2 shows a simple hardware implementation that connects an ESP8266 module to a temperature and humidity sensor (DHT11) to an Arduino board.

Both IoT devices connect to a 5-volt power source using a micro-USB interface. Depending on how each gadget is used, its power consumption ranges from 100 to 400 mA. The ESP 8266 device can be placed in deep sleep mode if a low reporting rate, such as one sample per second or less, is appropriate. For remote IoT device deployments, this mode is very helpful because it dramatically lowers the device's power usage.

2) IoT Device Streaming Telemetry

After successfully setting up the IoT devices, the reported data was verified on the local MQTT broker, confirming the successful streaming of telemetry data. Figure 3 displays the configured MQTT broker using the Paho MQTT client, showcasing published and subscribed data, along with a timestamp.

After the data is published on the MQTT broker the data is stored on the Cloud database through the Paho MQTT client for further data analysis process.

Overall, cloud-based storage and analysis, along with the automation of data collection using IoT devices and MQTT protocols, may considerably improve ESG reporting and assist businesses in becoming more sustainable, socially responsible, and accountable.

VIII. TABLES AND DIAGRAMS

Parameter	Sensor	Interface	Approx. Cost (USD)
Temperature	LM 35	Analog	0.5
Barometric Pressure	BMP085/ 180/ 280	I2C	1
Humidity	DHT22	1-Wire	4
Dust Sensor	GP2Y1010AU0F	Analog	5

Table 1. Various sensor parameters related to ESG

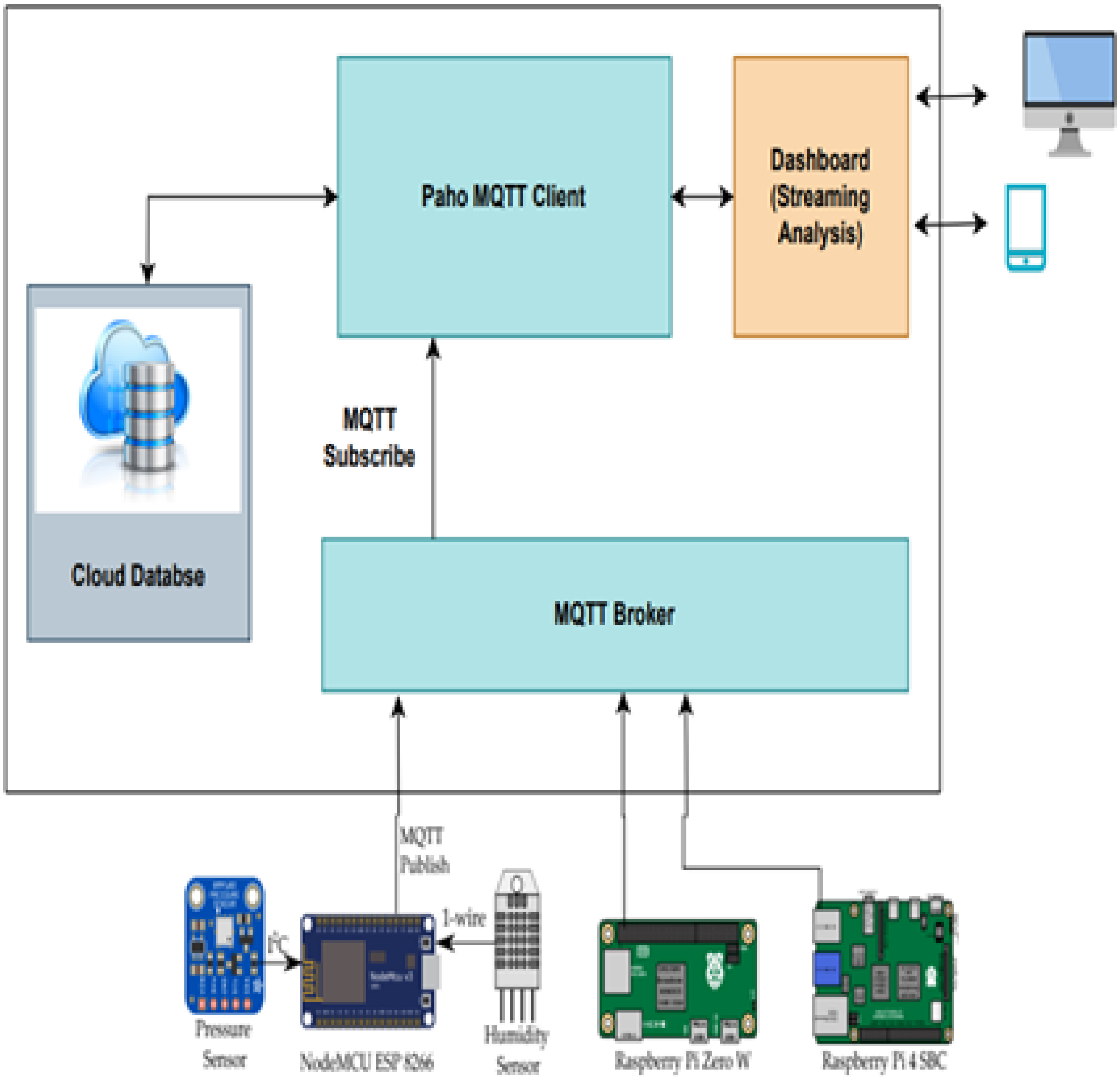

Fig 1. IoT Architecture

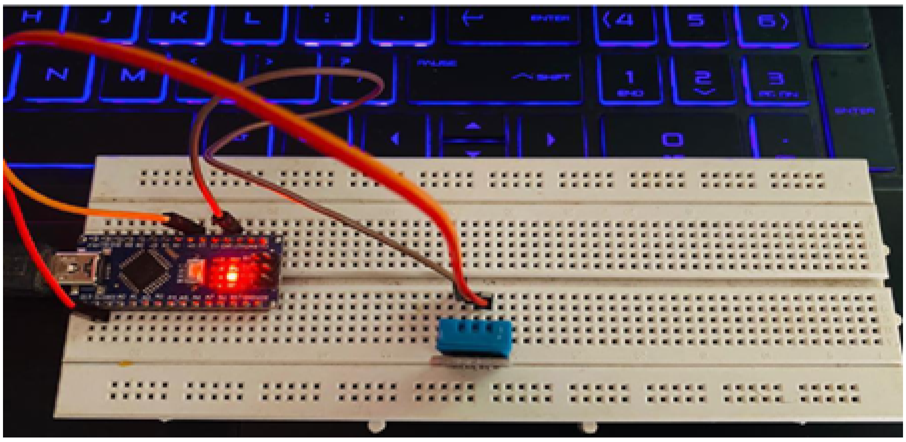

Fig 2. The IoT devices interfaced with a Temperature and Humidity sensor (DHT11).

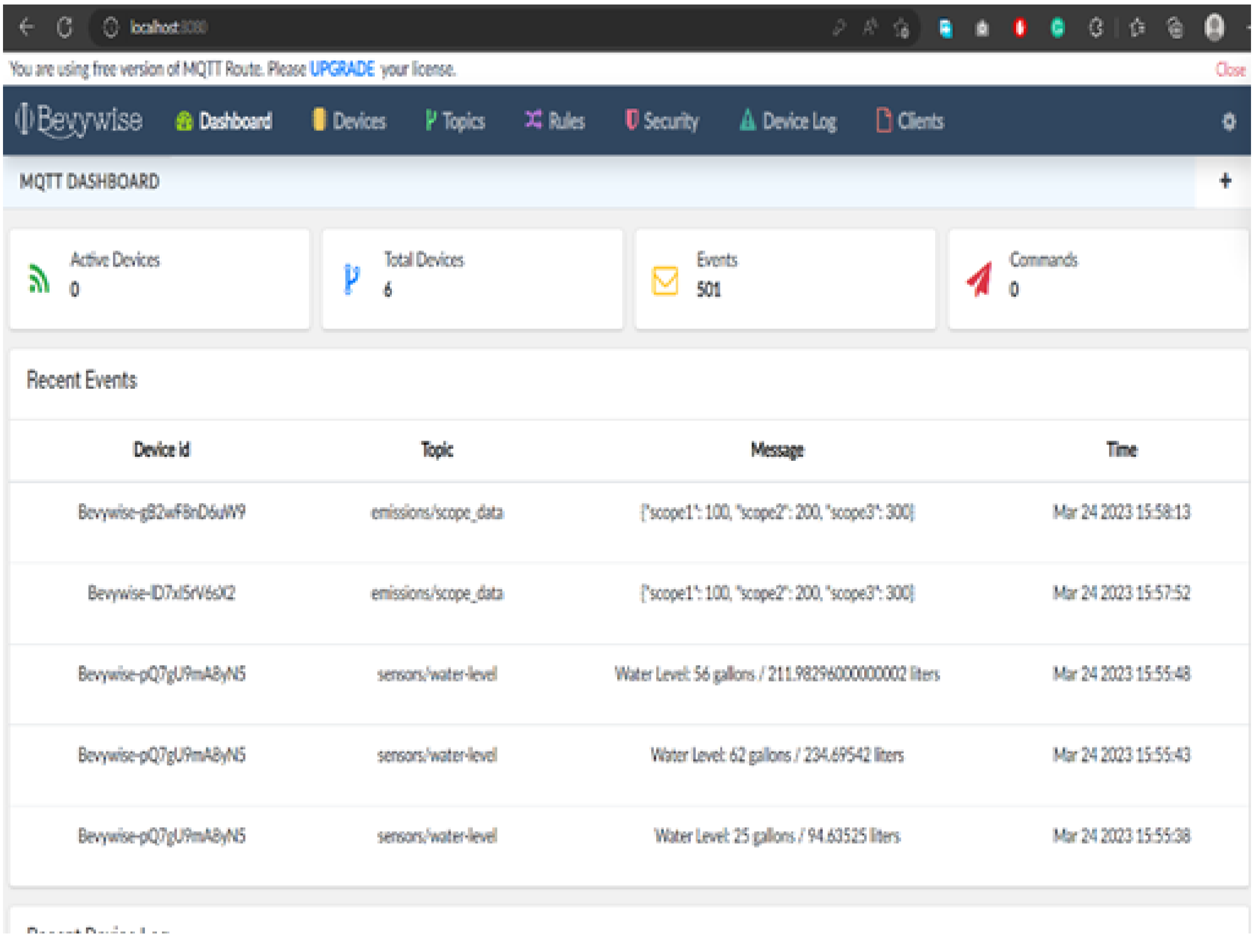

Fig 3. Bevywise MQTT Broker Dashboard

REFERENCES

[1] Sathiaram, S. (2022). ESG Adoption in the Indian Real Estate Sector: A Study. International Journal of Recent Advances in Multidisciplinary Topics, 3(1), 125-127.

[2] Gutterman, A. (2021). Sustainability Reporting Frameworks. Available at SSRN 3809288.

[3] Yu, W., Gu, Y., & Dai, J. (2022). Industry 4.0-Enabled ESG Reporting: A Case from a Chinese Energy Company. Available at SSRN 4063071.

[4] Saxena, A., Singh, R., Gehlot, A., Akram, S. V., Twala, B., Singh, A., ... & Priyadarshi, N. (2022). Technologies Empowered Environmental, Social, and Governance (ESG): An Industry 4.0 Landscape. Sustainability, 15(1), 309.

[5] Savazzi, S., Rampa, V., Kianoush, S., & Bennis, M. (2022). An energy and carbon footprint analysis of distributed and federated learning. IEEE Transactions on Green Communications and Networking.

[6] Madhura, S. (2021). IoT-based monitoring and control system using sensors. Journal of IoT in Social, Mobile, Analytics, and Cloud, 3(2), 111-120.

[7] Mohapatra, D., & Subudhi, B. (2022). Development of a Cost-Effective IoT-based Weather Monitoring System. IEEE Consumer Electronics Magazine.

[8] Hassan, Z., Hossain, G. J., & Islam, M. M. (2020). Internet of Things (IoT) based water quality monitoring system. Educ. Res, 2(4), 168-180.

[9] Jo, J., Jo, B., Kim, J., Kim, S., & Han, W. (2020). Development of an IoT-based indoor air quality monitoring platform. Journal of Sensors, 2020.

[10] Hassan, J. A., & Jasim, B. H. (2021). Design and implementation of Internet of Things-based electrical monitoring systems. Bulletin of Electrical Engineering and Informatics, 10(6), 3052-3063.