International Journal of Research and Applied Technology

3(2)(2024) 283-292
Journal homepage: https://ojs.unikom.ac.id/index.php/injuratech

Design and Implementation of Water Monitoring Program in Peatlands IoT Based

Tri Rahajoeningroem[1], Soni Nugraha[2]
[1, 2]Departemen Teknik Elektro, Universitas Komputer Indonesia, Indonesia

Email: [1]tri.rahajoeningroem@email.unikom.ac.id

Abstract. Forests and peatlands in Indonesia are experiencing constant degradation, caused mainly by farming activities, illegal logging, and forest fires. One way of addressing this problem is to restore the hydrology of the forest and peatland ecosystems through the monitoring water table and blocking the ditches and canals. Monitoring the water table aims to observe the groundwater level in the peatland area before and after the canal blocking was built. Building blocks and dams, it is expected that the water level and retention in the ditches and canals and nearby forest and peatlands will increase, reducing the danger of fire during the dry season and improving the possibility of rehabilitating nearby degraded land. An approach for a water monitoring program is based on a water level control system and hydrology logger. This large amount of water runoff will be monitored through high surface water data storage devices. The process of monitoring the water level is done continuously with integrating systems using IoT to obtain the latest condition data of hydrological variables in the field from a distance to be done various actions needed to avoid peatland forest fire.

Keywords: IoT, Internet of Things, Monitoring Program.

1. Introduction

There are 40 million hectares of tropical peatland in the world, with 50% (20 million hectares) found in Indonesia (Sumatra, Kalimantan, Papua, and a small amount in Sulawesi). Peat has several values, both extractive and non-extractive [1]. It is extracted for energy purposes (for example, briquettes of charcoal), for humic acid, for the rearing of seedlings, and for dry land reclamation. Non-extractive applications include acting as a wildlife refuge and supplying trees, plantations, and cultivation with the land. Even peat works as a hydrological barrier for nearby areas because of peat's capacity to store water (up to 90 percent of its volume) (protecting against flooding and intrusion of seawater). Forests and peatlands in Indonesia (especially in Kalimantan and Sumatra) are undergoing constant deforestation, mainly due to agricultural activities, irrigation networks (for example, those developed as part of the abandoned one-million-hectare peatland project in central Kalimantan), plantations, illegal mining, and land and forest fires. Degradation and degradation of forests and peat result in the resulting reduction or loss of the ecological and socio-economic roles of the peatlands.

One solution to solve this issue is to preserve the hydrology of forest and peatland habitats by controlling the water table and covering ditches and canals [2]. By doing so, the peatland area will be preserved and will help the human race. The purpose of controlling the water table is to observe the groundwater level in the peatland region before and after the canal blockage has been constructed. Building blocks and dams, it is expected that water levels and drainage in the ditches and canals and surrounding forest and peatlands will improve, thereby reducing the risk of fire during the dry season and increasing the potential to rehabilitate degraded land in the area [3].

Blocking the ditches and canals is a multidisciplinary physical intervention. Until blocking, certain scientific studies must be carried out, including soil characteristics, limnology, hydrology, flora in the local region, and socio-cultural characteristics.

In recent years, advances in computing and consumer electronics technology have initiated an Internet of Things (IoT) paradigm [4]. Internet of Things (IoT) is described as the enabler that links seamless objects surrounding the environment and performs some sort of message exchange among them. The Internet of Things (IoT) is a collection of objects that work jointly to serve consumer tasks in a federated manner [5] [6]. It binds computational power to deliver data about the surrounding environments [7] [8].

To achieve the expected result, an approach for a water monitoring program is based on a water level control system and hydrology logger. The water monitoring program uses an automatic water level that is an auxiliary device in water level readings. Usually, an automatic water level is placed on the flow of water runoff in large quantities continuously. This large amount of water runoff will be monitored through high surface water data storage devices. The process of monitoring the water level is done continuously.

2. Method

Based on Government Regulation No 57/2016 on Protection and Management of Peat Ecosystem, some points would be referred to the implementation of water level monitoring activities as mentioned in Figure 1. Some of these points are:

1. There is a supervisory control point called a peatland observation point.
2. The control points of the arrangement shall be determined by the directorate general based on the characteristic observation points on the Peat Ecosystem within the provincial and district or municipal areas and the groundwater monitoring point of the business or activity area.
3. Implementation of groundwater level measurements carried out by the party responsible for operations shall be established at least 15% (fifteen percent) of the total number of the stem of the main plant or production or activity block. It shall be used as long as within a radius of 50 (fifty) meters from the midpoint (centroid) of the main plant plot or block of production if outside the business permit is taken out by the Head of the Forest Management Unit or community group, this measurement is to know the damage of the Peat Ecosystem with the cultivation function and the protection function [1].
4. Distribution of groundwater facing points as well as land characteristics, topography, water management zones, canals or water structures and measurements of location, coordinates, and elevation of points of observation, water level, rainfall data, and time and date of measurement manual or automatic.

International Journal of Research and Applied Technology
3(2)(2024) 283-292
Journal homepage: https://ojs.unikom.ac.id/index.php/injuratech

Based on the point that has been mentioned above, the implementation plan activities are shown in figure 1.

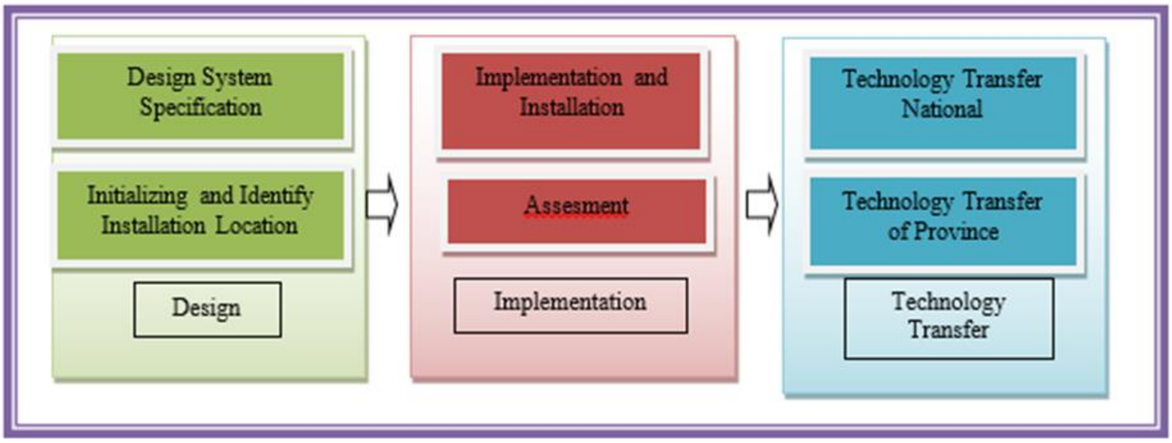

Figure 1. Working Methodology

An approach for the Water Monitoring program is based on the Water Level Control System and Hydrology Logger. The water monitoring program uses an automatic water level that is an auxiliary device in water level readings. Usually, the Automatic Water Level is placed on the flow of water runoff in large quantities continuously [9]. This large amount of water runoff will be monitored through high surface water data storage devices. The process of monitoring the water level is done continuously.

Results from the Automatic Water Level measurement are analog data and then processed with a microcontroller system to make digital data that can be read through the graph of the water level to the real-time measurement of the data. With the data already obtained, various decisions can be made to regulate the flow of water either by opening or closing the water canal through a remote control system.

In hydrology, respectively, it is used to push the energy behind wetlands and their essential roles. Measurement in hydrology gives insight into these features. Wetlands are characterized by three parameters: vegetation, soil, and hydrology [10]. Of the three, hydrology is the most variable and dynamic. Observing the hydrology variables required a data logger system that will store and transmit the existing data to server systems that can be accessed via the internet.

Data loggers are usually portable electronic storage instruments used to capture data for long periods. They record the data at the specified time intervals and then archive the data. Four of the most important data loggers used to track wetland hydrology are water depth, runoff, water quality, and air temperature/humidity loggers. The following suggests possible uses for data collection in these applications. Water table monitoring will be conducted on Londerang, Jambi; Berbak, Muaro Jambi – Jambi; Pulang Pisau, Central Kalimantan.

The approach used in conducting the Water Table Pilot Program implementation is made by approaching ICT management. Considering the system to be implemented is one of the ICT products. As in Figure 2, the Basis of the management is:

1. **Strategic alignment**: Aligning the functions and objectives of the implementation of the Water Table Pilot Program with the function and purpose of BRG;

International Journal of Research and Applied Technology

3(2)(2024) 283-292

Journal homepage: https://ojs.unikom.ac.id/index.php/injuratech

2. **Value delivery**: Optimizing the value achievement of the Water Table Pilot Implementation Program so that it can benefit optimally;
3. **Resource management**: Resource management of the built system must be implemented optimally and efficiently;
4. **Risk management**: Implement risk management tools properly and maximally;
5. **Performance measurement**: Measure the indicator of job success (achievement).

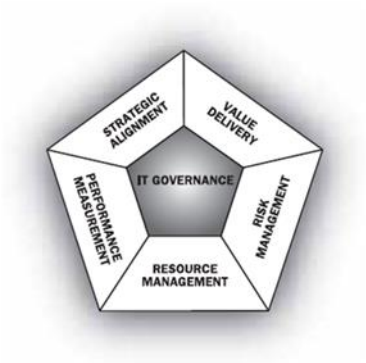

Figure 2. Approaching Model

Equipment that has been ready in use is expected to be installed not far from the watergate position to be in control. Weather statistics storage must take into account the needs of the solar light supply to be used to recharge the batteries. The distance of the system with the sensor should also be noted to maintain the accuracy of the data obtained.

For security, special treatment is required in store and install this system, considering all this equipment will be kept in an open space. To ensure that data loggers are safely placed, steps need to be taken to keep loggers out of direct sunlight and prevent them from harm caused by temperature, chemical environments, and wildlife. Some must be considered are:

1. Avoiding Elevating Temperatures: the procurement of temperature data in wetlands can have an effect on direct sunlight readings.
2. Avoiding degradation of metal parts: metal hooks, chains, and other metal parts can be quickly corroded in a wetland over time. This corrosion is caused by variations between aerobic and anaerobic environments. Spray metal posts with primer to resist corrosion. Spray metal hooks and chains with vinyl spray paint, such as Vinyl Spray. These precautions help keep data loggers properly installed over long periods.
3. Protecting Animals Equipment: Mice and other animals can chew via data logging cables. Run data logger cables through the vent to prevent this. In addition, bird excrement can be clogged by rain gages. To avoid this from occurring, use bird-reducing spikes, such as those from Bird along the edges of the rain gauge collector funnel.

3. Results and Discussion

3.1. Illustration of Monitoring System

In Figure 3, the monitoring system that we will offer to monitor the water level, temperature, and so on is the telemetry system. Electric energy requirement for monitoring equipment needs by using a solar cell. Monitoring data will be sent using a GSM signal and received by the recipient/receiver system located in the data monitoring center. The data monitoring center will act as sending commands to be received by the installation of Watergate control.

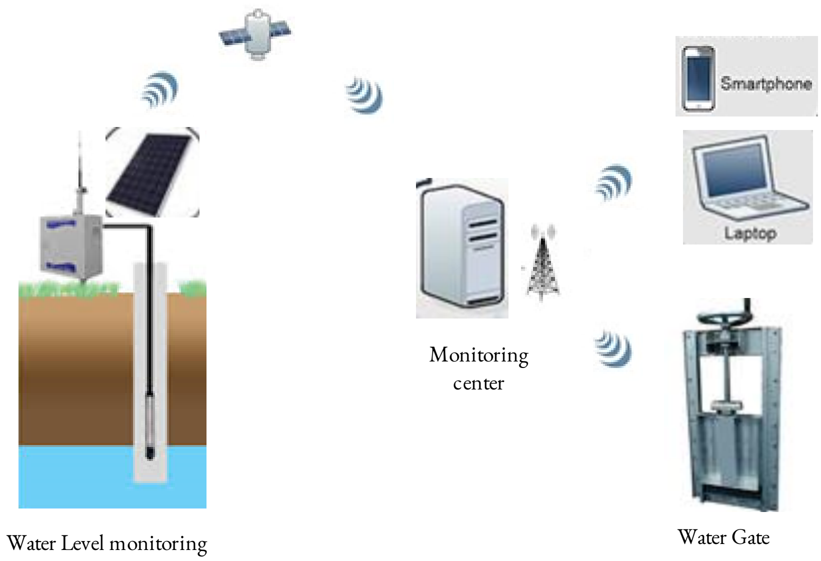

Figure 3. Illustration of Data Logging for Water Level Monitoring

The data monitoring center is also able to send data to the phone cell based on android. Only the control of the watergate in the field is still done through the data monitoring center.

3.2. Water Level Control System

Automatic Water Level is an auxiliary device in water level readings. Usually, the Automatic Water Level is placed on the flow of water runoff in large quantities continuously. This large amount of water runoff will be monitored through a high surface water data storage device. The process of monitoring the water level is done continuously.

Results from the measurement of Automatic Water Level is analog data and then processed with microcontroller system to make digital data that can be read through the graph of the water level to the real-time measurement the data, With the data already obtained, can be made various decisions to regulate the flow of water either by opening or closing the water canal through a remote control system.

3.3. Hydrology Logger

Hydrology is the driving force behind wetlands and their essential positions. Measurement in hydrology gives insight into these features. Wetlands are characterized by three parameters: vegetation, soil, and hydrology. Hydrology is the most variable and diverse of the three. To be able to observe the variables of the hydrology required a data logger system that will store and transmit the existing data to server systems that can be accessed via the internet.

Data loggers are usually portable electronic storage instruments used to capture data for long periods of time. They record the data at the specified time intervals and then archive the data. Four of the most important data loggers used to track wetland hydrology are water depth, runoff, water quality, and air temperature/humidity loggers. The following suggests potential uses for the processing of data in these applications.

3.4. Water level

Collected water level data helps researchers define a number of variables, such as how much water wetlands hold, rising water levels that threaten wildlife ecosystems, and whether runoff volume efforts are efficient.

3.5. Rainfall

Collected rainfall data shows how much rain has fallen in a given region. Researches also use this data to allow comparisons between the water stored and the runoff. Due to the spatial variability of rainfall, it is advised to quantify rainfall at several locations in order to achieve average rainfall for the region.

3.6. Water temperature

Collected water temperature data is also used to help researchers assess whether wetlands level water temperatures correctly before accessing the waterways.

Air temperature/Humidity. Collected air temperature and relative humidity data are usually used to assess the general health of wetlands and their effect on the temperature and humidity of their respective areas. Instead of entering the area, the user simply logs on to the website to access and retrieve the results. This saves travel time and minimizes data gaps due to the malfunction of the devices.

3.7. Control and Processing System

This section serves to receive and process data provided by the attached sensors. The main Control system is used as the main system processor when the data is being calculated, stored, and sent. Almost all running systems will be set by this microcomputer, from the data collection by the sensor until the data transmission is done via gsm module or GSM radio.

In general, as explained in Figure 4, all the processes that occur in this system are set and controlled by a control function through a microprocessor integrated with offline manual storage, all-analog data sent through the sensor will be converted to digital using an analog to digital converter component DAC (digital to analog converter) to be processed by the microprocessor and stored into storage in the system in the form of Sd Card storage component, once stored in the data storage component is received then will be sent via data senders such as GSM modem or radio. There are many microcontroller systems or microcomputers that can be selected to run this system, such as Raspberry Pi, Arduino, etc.

International Journal of Research and Applied Technology
3(2)(2024) 283-292
Journal homepage: https://ojs.unikom.ac.id/index.php/injuratech

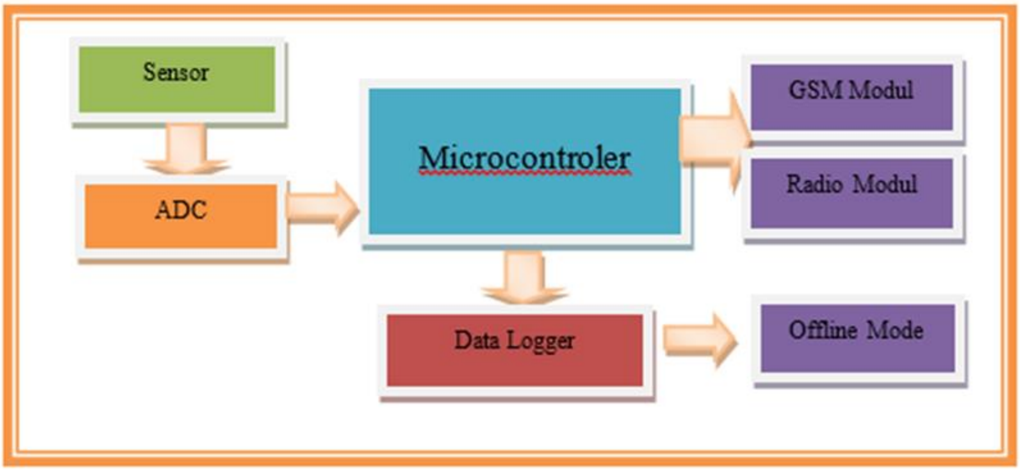

Figure 4. Data Flow Diagram

Figure 5 explains taking data for locations that cannot be accessed by GSM or Radio. A data retrieval system module can be accessed by visiting the location and accessing the system using android via a wifi connection to the installed system. In addition to being sent to the server, the data read by the sensor will also be stored offline in this storage system.

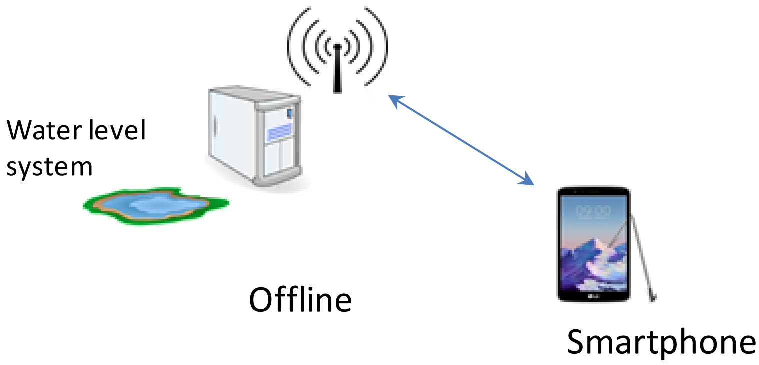

Figure 5. Taking Data to Offline Mode

After the process by the Control and Processing Section, the data will then be sent to the server at the center, there are three types of data transmission that can be done:

1. Data transmission via GSM Operator
   That is sending data through the GPRS signal from the operator as seen in Figure 6., if at that location there is a gsm signal

International Journal of Research and Applied Technology

3(2)(2024) 283-292
Journal homepage: https://ojs.unikom.ac.id/index.php/injuratech

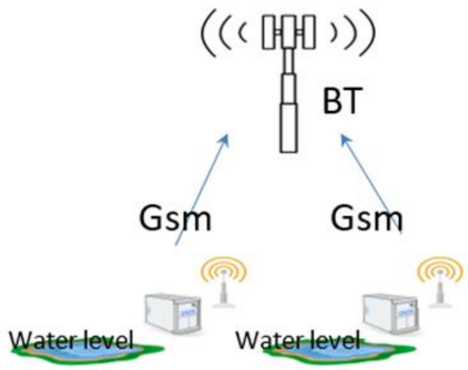

Figure 6. GSM Base Data Transmission

2. Data transmission via radio
   Figure 7 shows if the location of the placement of the device is not found, gsm signal will be used radio signals, which will be sent to the nearest location of the device that has a gsm signal.

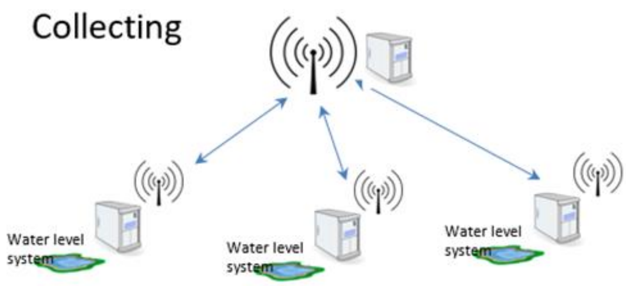

Figure 7. Radio Base Data Transmission

3. Delivery of data at locations not connected to either radio or GSM network
   Figure 8 shows if the location cannot be connected to the radio or GSM interconnection model, then must be provided a system that can be accessed manually by visiting the location of the installed system.

Figure 8. Offline Mode Data Collecting

3.8. Development Process of Water Table Monitoring System

There are four stages in the development process of the water table monitoring system mentioned in Figure 9:

1. *Design Stage*. At this stage, there are two main activities there are
   a. *System Design and Specifications*. Will be done design and design of the system to be built, include the concept and technology tools that will be implemented in the device installation and interconnection and networking for data communication from device infield and the server in the central system.
   b. *Identify Cellular Network in location for installation System*. Given that in the system design and network interconnection that has been explained above, there are three main types of equipment that will be in use, that is, the equipment will be directly connected to the GSM network. The equipment only has a radio modem, and equipment that has a function both as a data collaborator Will be sent to the center. Since these three devices have different functions and details, it is important to survey and identify the location or point to be installed. So it can be done planning and mapping of the appropriate install point following the function of the equipment described above.
2. *Implementation and Installation Stage*. At this stage will be the implementation of equipment and installation of the equipment. And will be tested and trial data in real-time.
3. *Assessment Stage*. In this stage will be made Standard operation procedure for the system implemented. Besides that will also be prepared standard Specification that can be used for the system water table monitoring program.
4. *Transfer Knowledge Stage*. At this stage, it will be transferred technology in the form of training conducted in national and in the province that installed this system.

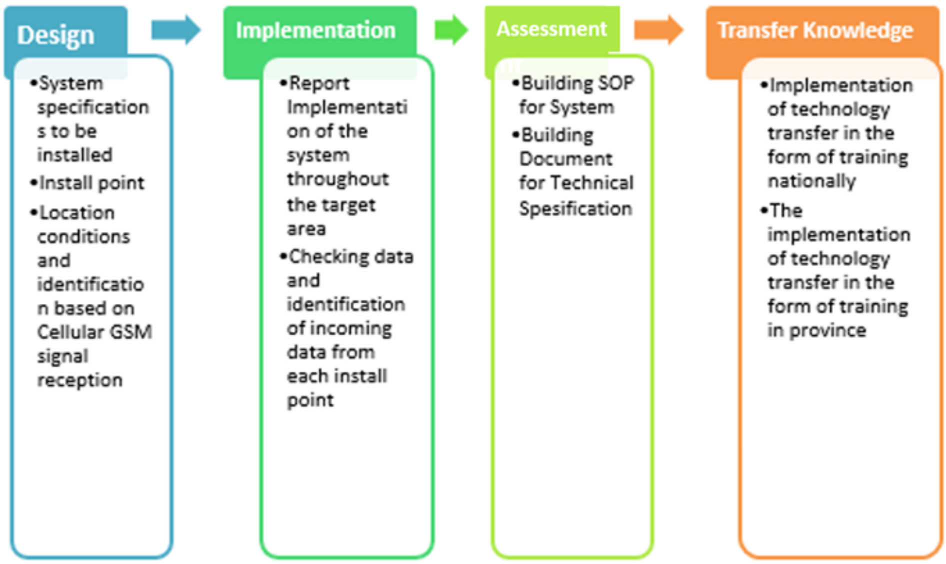

Figure 9. Development Process of Water Table Monitoring

4. Conclusion

Based on the findings of this study, it was concluded that managing the water table is the main way to solve this issue is to preserve the hydrology of forest and peatland environments.

Monitoring the water table aims to observe the groundwater level in the peatland area before and after the canal blocking was built. With the water level system, we can get the water level data quickly. This data can be integrated with the control system to control the remote-controlled watergate remotely. With a hydrological logging system and using IoT technology to integrate the system, it is expected to obtain the latest condition data of hydrological variables in the field from a distance to be done various actions needed to avoid peatland forest fire.

References

[1] Tsunoda, T. (2015). *The Dawn of cinematic modernism: Iwanami Productions and postwar Japanese cinema*. Yale University.

[2] Ramankutty, N., Gibbs, H. K., Achard, F., Defries, R., Foley, J. A., & Houghton, R. A. (2007). Challenges to estimating carbon emissions from tropical deforestation. *Global change biology*, *13*(1), 51-66.

[3] Aust, W. M., & Lea, R. (1991). Soil temperature and organic matter in a disturbed forested wetland. *Soil Science Society of America Journal*, *55*(6), 1741-1746.

[4] Perumal, T., Sulaiman, M. N., and Leong, C. Y. 2015. Internet of Things (IoT) enabled water monitoring system. In 2015 IEEE 4th Global Conference on Consumer Electronics (GCCE) (pp. 86-87). IEEE.

[5] Sin-wai, C., Kin-wah, M., & Ming, L. S. (2024). *Routledge Encyclopedia of Technology and the Humanities*. Routledge.

[6] Dave, E. (2011). How the next evolution of the internet is changing everything. *The Internet of Things*, 2011.

[7] Perumal, T., Sulaiman, M. N., Mustapha, N., Shahi, A., & Thinaharan, R. (2014, October). Proactive architecture for Internet of Things (IoTs) management in smart homes. In *2014 IEEE 3rd global conference on consumer electronics (GCCE)* (pp. 16-17). IEEE.

[8] Perumal, T., Sulaiman, M. N., & Leong, C. Y. (2013). ECA-based interoperability framework for intelligent building. *Automation in Construction*, *31*, 274-280.

[9] Taylor, C. J., & Alley, W. M. (2001). *Ground-water-level monitoring and the importance of long-term water-level data* (Vol. 1217). Denver, CO, USA: US Geological Survey.

[10] Twilley, R. R., & Rivera-Monroy, V. H. (2005). Developing performance measures of mangrove wetlands using simulation models of hydrology, nutrient biogeochemistry, and community dynamics. *Journal of Coastal Research*, 79-93.