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Design of Environmental Detector System (EDS) application through industrial and vocational collaboration

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Abstract - Politeknik Negeri Medan (POLMED) as a vocational institution and PT Berkat Solusi Teknik as a partner have the same responsibility to solve problems that exist in society. Problems in society related to pollution from industrial waste. This is due to many complaints from the public, NGO, and other organizations regarding environmental damage due to production and economic activities. Based on the problems above, this study is needed to detect and monitor environmental parameters such as CO_2 level, lighting, noise, temperature, humidity, and measurement data that can be accessed and displayed in real-time via the internet. The implementation method is strengthening work organization, making EDS prototype brackets, design of an environmental detector system (EDS) prototype, prototype testing, MBKM internship, international conferences, monitoring and coordinating with partner, internal monitoring, and evaluation I and II, and preparation of final report. We innovate in the selection of components and the technology used. This collaboration is a symbiotic mutualism between POLMED and industry. The results are in average values, namely the density of dust particles is 1.418 μg/m3. Temperature 36.60oC. Humidity 53.82%RH. Light intensity 10,615 lux. These values above are still normal condition, and there is no pollution in campus. Especially for temperature and humidity. This condition above on the threshold.

Keywords: environmental detector system (EDS), industry, matching fund program, vocational institution

1 Introduction

Politeknik Negeri Medan (POLMED) as a vocational institution and PT Berkat Solusi Teknik as a partner have the same responsibility to solve problem that exist in society. Problems in society related to pollution from industrial waste. This is due to many complaints from the public, NGO, and other organization regarding environmental damage due to production and economic activities, such as increasing emissions and concentrations of CO_2 [1], respiratory problems due to increased dust particles in the air [2], climate changes in extreme temperature and humidity resulting in disrupting

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food production in Indonesia [3][4], and the impact of noise on the health of workers and the public [5].

So the Indonesian Government has issued various regulations to maintain environmental conditions, which are outlined in threshold values for environmental parameters such as CO_2 levels in the air max. 3180 ppm [6], lighting min. 150 lux [7], noise max. level 97 dB [8], temperature 26–30^{o}C [9], humidity 65–95% [10]. POLMED and partner have agreed on how to implement this automation system so that it can be integrated with internet of things technology so that this system can detect and monitor certain objects and parameters from long distances via the internet.

Based on the problems above, this study is needed to detect and monitor environmental parameters such as CO_2 level, lighting, noise, temperature, humidity, and measurement data that can be accessed and displayed in real-time via the internet. This environmental conditions around the factory or industrial area can still be monitored, and this system will later become an indicator of environmental conditions to determine the direction of policy taken by the management or owner regarding mitigation if conditions are in extreme circumstances.

This collaboration is a symbiotic mutualism between POLMED and industry. This collaboration will have immediate benefits tangible for society. People will be comfortable living in factory or industrial environments because environmental conditions are maintained and can be monitored. The benefit for partner is the diversification of services and production from the company. Partner can expand the market into new services and commerce. Previously, partner was already established in the PLC device, so with this innovation, partner can get new business opportunities in detection and monitoring systems. Benefits for POLMED, achieving key performance indicators (KPI) in accordance with the decree of the Minister of Education and Culture of Republic of Indonesia No. 3/M/2021 concerning in KPI for universities, politeknik, and higher education service institutions.

2 Materials and methods

This research was built in 2021, the applicant had conducted research related to the system for detecting and monitoring the level of environmental pollution that occurred on the POLMED campus [11]. This research has been published in reputable international proceedings at link: https://www.atlantis-press.com/proceedings/bis-ste-20/125959929. Based on this research, the author has succeeded in detecting and monitoring parameters such as dust particle density in air, temperature and humidity, light intensity, CO_2 level, and noise level. The detection results are still in normal condition, because from 2020 to 2021 the campus is still in a state of lockdown. Research in 2021, focuses on how to develop IoT-based components such as sensors, SIM800 communication modules, and ESP32 microcontroller as well as developing web-based software and using a virtual private server (VPS) as a webserver. The tools in this research are called Environmental Pollution Monitoring Tools. It will be the baseline for the development of creative innovations in the Matching Fund Program in 2023.

In 2022, research will focus more on innovation in IoT-based components and certain market segments. One of the components developed is the use of a communication module from sim800 to sim7600 and implementation of the device on oil palm plantations. This research is about a system for detecting CO_2 level in oil palm plantations [12]. It has been published in a reputable international journal with the link: http://journal.gpp.or.id/index.php/ijrvocas/article/view/171. This innovation was carried out because of the communication module sim800 has been banned for use in Indonesia. For this reason, author replaced it with sim7600.

2.1 Method

In 2023, this research will be carried out and the series of activities in this program include:

2.1.1 Strengthening work organization

These activities include (1) sharing perceptions regarding increasing commitment and vision of activities [13]; (2) brainstorming regarding division of tasks and synergy in scientific fields [14]; (3) a workshop on policy briefs about policies and central issues in matching fund programs [15]; (4) training of trainers (TOT) in scientific fields that are in accordance with creativity [16]; (5) training in scientific fields that are suitable for students; (6) mentoring and monitoring activities for students who have taken part in TOT, and (7) develop terms of reference (TOR) with the partner.

2.1.2 Making EDS prototype brackets

The bracket functions as a stand or holder for the EDS prototype and is planned to be carried out. This activity includes welding the frame iron seat or holder. A bracket is an intermediate component used to fix one thing to another. It may be thought of a kind of fastener, but this is somewhat misleading, actual fasteners like screws are used to connect the bracket to the other parts. In addition to creating a connection between two parts, a bracket may provide support. Some brackets, such as gusset brackets, are designed with a diagonal section that reduces the strain on the bracket and allows it to support heavier loads. One of the easiest and most cost-effective ways to make brackets, especially simple ones like angle brackets, is sheet metal fabrication. Brackets typically consist of two or more planes connected along one edge, and often to simplest way to fabricate this kind of object is to bend a flat object (i.e. a piece of sheet metal) in two or more places: the simplest example would be adding a 90° bend to a flat rectangle with a straight profile, turning it into a bracket with an L-shaped profile.

2.1.3 Design of an EDS prototype

This prototype is divided into 5 main blocks, namely: sensor block, IoT gateway block, connectivity block, cloud server block, and application block. An EDS prototype was designed as shown in Fig. 1. The sensor used is the type that has a special socket for the LoRa node. So, each sensor will be equipped with a LoRa node to make it easier to send measurement data to the gateway and facilitate scalability if the number of parameters being measured increases. The following are the differences in innovation in the sensor sector this year and the previous year, as seen in Fig. 1.

The innovation in this block is that all sensors and LoRa nodes are connected to the IoT Gateway device. This block also uses a PLC connected by a LAN cable with an HMI (human machine interface) type so that staff and employees in the factory can monitor environmental conditions around the factory. PLC is also used because PLC is an automation control system that is well established and familiar in Indonesian industry. This aims to facilitate the development of devices in a commercial direction. The IoT Gateway block diagram can be seen in Fig. 2.

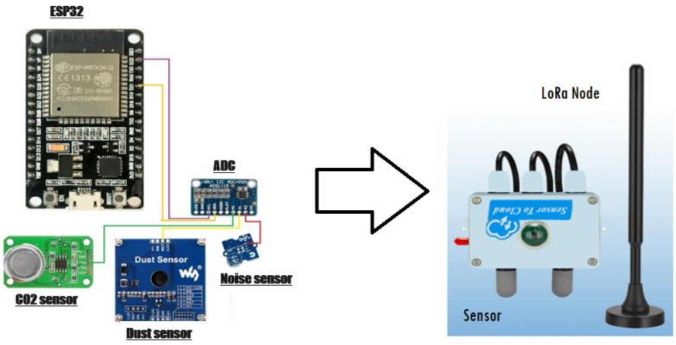

Fig. 1. Innovation on sensor block.

The innovation in this block is the connection from the LoRa node to the IoT gateway using RF waves with a transmit distance of up to 2 km according to LoRa specifications. This aims to efficiently use internet data packages. connection from the IoT gateway to the cloud server using a GSM network. This is due to the advantages of the GSM network, which has a stronger and more stable signal and a wider network in Indonesia. Many factory locations are on the outskirts of large cities; it is hoped that with the GSM network, the detection and monitoring system can be carried out well.

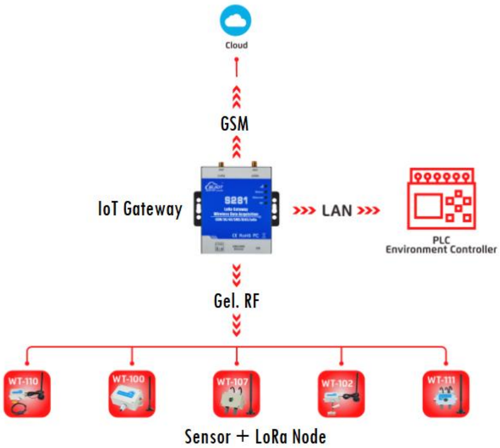

Fig. 2. IoT gateway diagram block.

The innovation in this block is the use of a KPI (key performance index) dashboard for laptop and smartphone users. This dashboard is generally used for business activities, but it can also be used for monitoring activities because it is interactive, accurate, real-time, and analytical.

2.1.4 Prototype testing

Prototype testing is planned to be carried out in the field of testing, namely cellular technology, and RF waves. The industry term RF stands for radio frequency, which is any frequency within the electromagnetic spectrum that is used or associated with radio wave propagation. In the simplest of terms, supplying an RF current to an antenna creates an electromagnetic field, which is then able to transmit energy through space. Many of the wireless technologies used today are based on radio frequency field propagation, including mobile test stations and other wireless functional test fixtures. RF functional testing is an important tool in the electronic test industry and is requested by many of our clients.

The telecommunications industry relies heavily on RF energy for the broadcast of television and radio waves, as well as for cellular phones and communications for first responder departments.

Satellite communications, amateur radio, and even microwave point-to-point links are also some of the most widely used telecommunications applications that utilize radio frequency. However, there are many non-communications applications for RF energy, including microwave ovens, industrial heating, and radar for things like traffic enforcement. However, the type of radio frequency application that we are most interested in for this website is for RF functional testing for manufacturing.

There are many different types of functional test fixtures that are used by the electronic test industry. Whether a client prefers a computer-based mobile test station or some other type of wireless functional test interface, they will be relying on radio frequency to get the job done. Industrial testing of RF components and other products is important for quality control and consistency for modern manufacturers. RF functional testing is also used to ensure that an RF controlled product does not introduce intolerable electromagnetic disturbances into the environment. This type of testing checks for RF immunity and emissions.

2.2 Activity management

Partner has a slogan, namely "Long Term Relationship Through Total Satisfaction." This is a positive message of commitment to very high standards and very detailed attention to clients. So, our institution, POLMED, has collaborated with a partner in a Memorandum of Understanding (MoU) regarding programming logic control (PLC) training collaboration for POLMED students and the community. This collaboration has contributed to the process of developing PLC skills education for POLMED students, especially students of the Electrical Engineering Department.

Based on this strong commitment, it is hoped that this collaboration can develop the Environmental Detection System (EDS) prototype up to *Technology Readiness Level* 7. This system has been tested in a real environment. The partner will assist in terms of equipment, technology, funds, and domestic component level certification for the components to be used, while the author will provide expertise and skilled personnel in the form of students.

3 Results and discussion

An EDS prototype was measured as shown in Table 1. Measurements were carried out in the morning around the POLMED campus.

The results of the measurement data must be compared with regulatory standards set by the government. This is to find out whether environmental conditions are normal or dangerous. Standard regulations by Indonesian Government are following:

1. Minister of Environment Regulation No.12/2010: PM-2.5 dust particle density max. 66 μg/m^3 and CO_2 level in the air max. 3180 ppm.
2. Minister of Health Regulation No.70/2016: light intensity min. 150 lux.
3. Minister of Manpower and Transmigration Regulation No.13/2011: max noise level. 97 dB.
4. Minister of Manpower, Transmigration and Cooperation Regulation No.1/1978: temperature 26^{o}C – 30^{o}C and air humidity 65%RH - 95%RH.

Based on the data measurement results in Table 1. The results are calculated in average values, namely the density of dust particles is 1.418 μg/m^3. Temperature 36.60^{o}C. Humidity 53.82%RH. Light intensity 10,615 lux. These values above are still normal condition, and there is no pollution in campus. Especially for temperature and humidity. This condition is above the threshold. We have taken measurements during the day, so the temperature measured is very high or hot and dry.

Table 1. EDS prototype measurement results

Time	Measurement results					
	CO_2 (ppm)	**Dust (μg/m^3)**	**Light (lux)**	**Temperature (^{0}C)**	**Humidity (%RH)**	**Noise (dB)**
2023-10-24 09.56.06	25.00	0.43	10,872	36.02	54.59	2.87
2023-10-24 09.56.11	25.00	1.97	11,102	36.13	55.45	5.32
2023-10-24 09.56.17	25.00	0.95	11,072	36.08	55.31	5.27
2023-10-24 09.56.22	25.00	0.95	11,032	36.17	55.39	4.07
2023-10-24 09.56.26	25.00	0.95	10,982	36.23	55.10	4.16
2023-10-24 09.56.31	25.00	2.47	10,892	36.26	55.14	3.56
2023-10-24 09.56.36	25.00	0.94	10,832	36.32	55.12	5.67
2023-10-24 09.56.41	25.00	1.45	10,732	36.35	55.19	2.82
2023-10-24 09.56.46	25.00	0.94	10,612	36.41	55.32	3.20
2023-10-24 09.56.51	25.00	0.94	10,592	36.54	55.63	2.87
2023-10-24 09.56.57	25.00	2.98	10,082	36.68	54.81	3.44
2023-10-24 09.57.01	25.00	0.94	9,732	36.67	55.10	5.92
2023-10-24 09.57.06	25.00	0.43	10,382	36.72	54.10	3.35
2023-10-24 09.57.11	25.00	0.95	10,502	36.71	53.90	2.90
2023-10-24 09.57.16	25.00	1.45	10,512	36.70	53.93	3.97
2023-10-24 09.57.22	25.00	1.45	10,662	36.69	53.73	3.33
2023-10-24 09.57.27	25.00	1.45	10,552	36.66	53.50	4.68
2023-10-24 09.57.32	25.00	2.47	10,402	36.67	53.41	3.51
2023-10-24 09.57.36	25.00	0.43	10,212	36.68	52.89	3.38
2023-10-24 09.57.41	25.00	0.95	10,082	36.72	52.58	3.27
2023-10-24 09.57.46	25.00	1.96	9,972	36.76	52.36	1.78
2023-10-24 09.57.51	25.00	0.94	10,722	36.76	52.07	3.81
2023-10-24 09.57.56	25.00	2.98	10,692	36.78	52.13	1.44
2023-10-24 09.58.02	25.00	1.45	10,622	36.81	52.13	3.25
2023-10-24 09.58.07	25.00	0.43	10,562	36.82	52.17	5.09
2023-10-24 09.58.11	25.00	2.47	10,572	36.88	52.44	3.09
2023-10-24 09.58.16	25.00	3.49	10,722	36.95	52.35	2.61
2023-10-24 09.58.21	25.00	0.94	10,842	36.91	52.75	3.28
2023-10-24 09.58.27	25.00	0.43	10,852	37.03	52.33	3.24
2023-10-24 09.58.31	25.00	1.96	11,052	36.95	53.67	2.69
Average	25.00	1.418	10,615	36.60	53.82	3.59

4 Conclusion

This collaboration is a symbiotic mutualism between POLMED and industry. This collaboration will have immediate benefits for society (tangible). People will be comfortable living in factory or industrial environments because environmental conditions are maintained and can be monitored. The benefit for the partner (tangible) is the creation of diversification of services and production from the company. A partner can expand the market into new services and commerce. Previously, partners were already established in the PLC field, so with this innovation, partners can get new business opportunities in detection and monitoring systems. The benefit for partners (intangible) is that industry and vocational institutions have established sustainable research relationships, and industry has no shortage of research personnel in Indonesia.

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