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SMART SEAL BASE ON WIFI USING WEB SERVICE PHP

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ABSTRACT

Technological developments, especially in the IoT (Internet of Things), play a significant role in various fields. In addition to achieving a modern and efficient work environment, IoT can also play a role in the security sector, which has now become a significant need. One of the roles of IoT in the security sector is that it can be applied to calibrated TMWE (Measuring, Dosing, Weighing, and Equipment). So that it can guarantee the correctness of the measurement results from the TMWE, continuous monitoring can be carried out so that fraud does not occur. One of the innovations in this regard is the smart seal. The use of smart seals is prioritized for fixed TMWE, which is vulnerable to theft and breaches. This system is designed based on IoT, which is integrated with cloud services and GPS systems that allow the use of web-based applications for online monitoring of seal conditions by users. Data from the seal will be sent to the server via WiFi network and stored in a database, to be displayed in web service with a user, admin, and signer access. In addition to providing information to users about the seal's location, the use of the GPS also aims to make it easier for admins to detect the seal's location in the event of a violation.

Keywords: Internet of Things, smart segel, cloud, GPS, web service

INTRODUCTION

Metrology is the science of measuring broadly. Based on Law no. 2 of 1981 concerning Legal Metrology. Legal metrology manages units of measure, measurement methods, and instruments regarding technical and regulatory requirements based on the Legal Metrology Act. The purpose of the enactment of the law is to protect the public interest through the certainty of measurement and the existence of measurement and legal certainty in the use of units of measure, standard units, measurement methods and Measuring Tools, Measures, Weight, and their Equipment (TMWE), and in particular in the context of to supervise TMWE circulating in the community. At this time, there are often various incidents of the use of TMWE. This is of course, carried out by irresponsible persons to gain profits. One part of TMWE that is vulnerable to fraud is the tera seal. The metrological seal is a metrological sign affixed to plombir lead with wires that damage the TMWE, which at the time of a change or violation of the TMWE through the seal, it is often not known or detected. Therefore, with current technological developments, systems that work automatically through wireless applications in a network are integrated, so that smart seals are developed to overcome these problems. Technological developments make IoT (Internet of Things) very popular today.

IoT technology is an effort to achieve an effective and efficient modern scope of work. This can be applied in the use of smart seals. Smart seals can be applied to various types of TMWE in general, but the use of smart seals is prioritized for TMWE that are prone to violations, TMWE whose locations are fixed and TMWE that are prone to theft because they have a high selling price. For example, this smart seal can be applied to kWh meters, gas meters, water meters, fuel oil metering pumps, and other TMWE. This smart seal functions as a supervisor to monitor the truth and fraud that occurs in TMWE. The prototype system is designed based on IoT (Internet of Things) which is integrated with cloud services, thus enabling two-way communication using web-based applications. As for this prototype, it uses a transmission network based on WiFi (Wireless Fidelity) as a medium for sending data on the condition of the smart seal. The data from the seal will be sent to the server when the condition is disconnected or connected. The data that has been sent to the server will then be stored in a database on the server. In addition, the smart seal is equipped with a GPS (Global Positioning System) system, so the user can know the condition and location of the TMWE seal through a web service that can be monitored online by the user. Besides being able to allow users to find out the location of the smart seal, the use of a GPS module can also make it easier for admins to be able to detect the location of TMWE if there is an indication of a violation

METHOD

The design of the electronic smart seal uses several modules, namely the GPS NEO 6M-V2 module, ESP 32 Microcontroller, WIFI, Ni-MH Batteries, and Micro Current Amplifier Circuit. Sending data using WiFi to the server, and the user can access it via a web service.

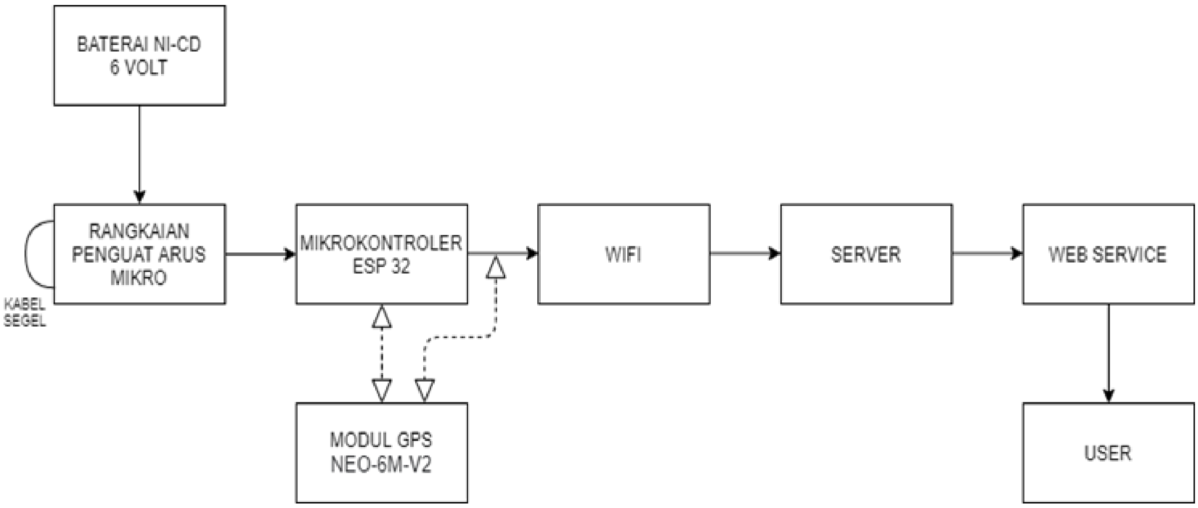

FIGURE 1. Smart Seal Block Diagram

The working principle of this smart seal is that when the seal cable is disconnected, a signal containing information on seal damage will be sent. In the smart seal prototype, there is a microcurrent amplifier circuit connected to the seal cable. This microcurrent amplifier circuit consists of a resistor as a voltage divider and a transistor as a microcurrent amplifier. The output current from the microcurrent amplifier circuit will function to activate the ESP32 microcontroller and the NEO-6M GPS module. The use of relatively simple components aims to reduce the power consumption used in the working mechanism of the smart seal prototype. In data processing, ESP32, which functions as a microcontroller, will send data in the form of seal conditions. In addition, the ESP32 microcontroller will also provide a voltage supply to activate the NEO-6M GPS module and provide location information from the smart seal. The seal condition and location data will be sent by the ESP32 microcontroller via the WiFi network to the server and will be reported in the web service. So that it can be monitored online by the user.

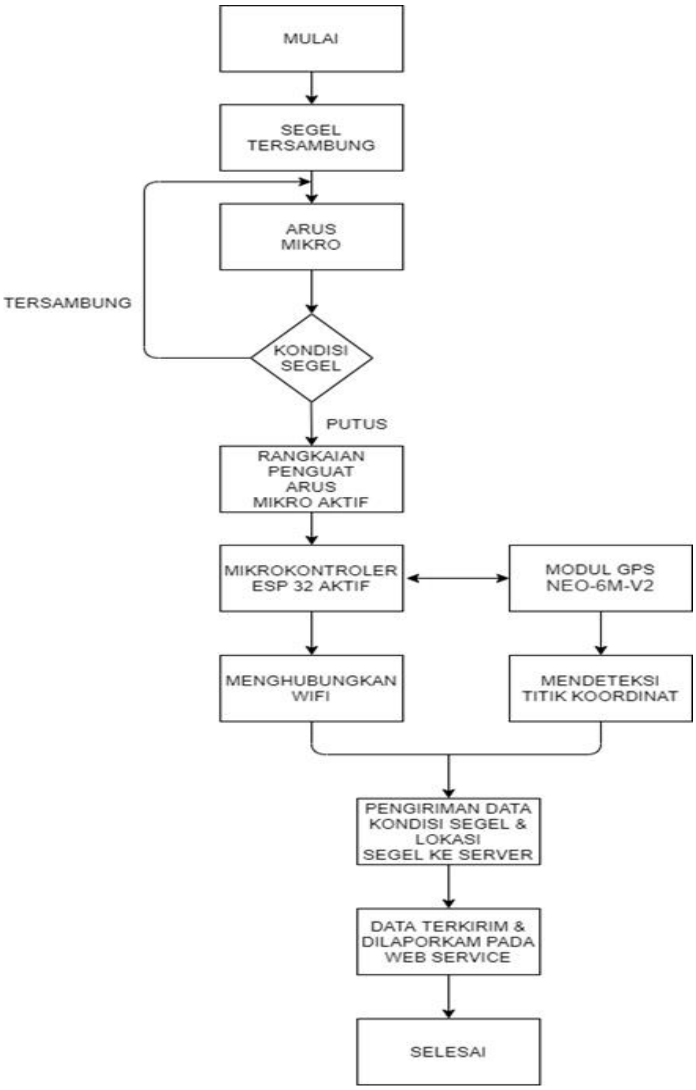

FIGURE 2. Smart Seal Principle Diagram

The smart seal is composed of several electronic components that automatically report data when the seal condition is broken or there is an indication of a violation. When a seal is broken or violated, the seal will report the seal condition online via a WiFi network to a web service. Meanwhile, there are two operating conditions of this smart seal prototype are:

Standby Condition

A standby condition is a condition when the seal cable is connected. This seal cable will connect the battery to the ground so that electric current can flow through a resistor with a resistance of 30 MΩ. Resistors with large nominals are used to pass as little current as possible so as not to consume a large amount of battery power. The battery, the supply voltage for the electronic circuit in the prototype smart seal has a voltage of 6 Volts with a battery capacity of 4000 mAh, so the current flowing through the resistor is 0.2 A. With this battery capacity, ideally, in standby conditions, the battery can last more than one year. In this circuit, the greater the resistance value of the resistor, the less power is consumed by the battery, so the battery can last a long time.

In its implementation, this smart seal is used in TMWE, which can be used as a substitute for CTT (Cap Tanda Tera) because it has a durability of more than one year. In addition, the use of rechargeable batteries makes it possible to recharge the battery again in one calibration period.

The Condition of the Cable Disconnected

The disconnected cable condition is where the seal cable is disconnected or detached from the circuit. When the seal cable is disconnected, current will flow automatically through the microcurrent amplifier circuit so that the current in the micro order is amplified three times by 2 NPN transistors of type C828 and 1 PNP transistor of type C9012. The output current of the microcurrent amplifier circuit will activate ESP32 as a microcontroller for sending data according to the program that has been uploaded. In addition, the ESP32 will also activate the NEO-6M GPS module, which will provide location information from the smart seal. Data from the condition and coordinates of the seal will be sent to a MySQL database server with a WiFi network which will be reported in the web service in the form of a map with a red padlock image for broken seal conditions and blue padlocks for connected seal conditions. In addition, on the web service that has been created, there are several widget features such as login menu, home, seal location, seal graph and table of seal location and status. Sending data from the smart seal uses the POST method, which can receive information from the microcontroller, then send it to the MySQL database in real-time.

RESULT AND DISCUSSION

The test result consists of several tests described as follows.

Current Consumption Test

TABLE 1. The result of the current consumption test.

Condition	The Current Consumption of Load	1	2	3	4	5	$\bar{x}$
Seal Disconnected	Current Amplifier Circuit (mA)	18.68	17.89	17.91	18.57	18.63	18.34
	ESP32 Microcontroller (mA)	15.58	16.17	16.42	16.33	16.39	16.18
	GPS Module NEO-6M (mA)	13.72	11.98	13.52	13.81	12.79	13.16
Current Comsumption (mA)		47.98	46.04	47.85	48.71	47.81	47.68
The Minimum Current Comsumption (mA)		45.45					
The MAximum Current Comsumption (mA)		48.82					

Current consumption testing is carried out to determine the amount of current required for each electronic circuit component on the smart seal to be active so that it can transmit data. This test measures the current consumed by each component of the electronic circuit (electrical load) on the smart seal, such as the microcurrent amplifier circuit, the ESP32 microcontroller and the NEO-6M GPS module.

The results of the current consumption test used when the seal is broken for each electronic circuit component on the smart seal include, among others, the average current consumed in the microcurrent amplifier circuit is 18.34 mA, the average current consumed in the microcurrent amplifier circuit is 18.34 mA. ESP32 microcontroller is 16.18 mA, and the average current consumption of the NEO-6M GPS module is 13.16 mA. So that the total current consumption average for all components is 47.68 mA, with a maximum total current consumption of 48.82 mA. The average total current consumption of the smart seal is 47.68 mA, using a battery supply with a power capacity of 4000 mAh. Theoretically, the smart seal can be used for data transmission 84 times. In standby condition, that is, when the seal cable is connected, the seal cable will be connected to the ground and the electric current will pass through a resistance of 30 MΩ. The current will be passed as small as possible so it does not consume large battery power. In other words, under ideal conditions, the current consumed by the smart seal is close to 0 (0.2 A). With this battery capacity, ideally, the battery will last more than one year in standby.

Send Coordinate Data Test for GPS NEO-6M Module

The test of sending coordinate point data is carried out to determine the length of time the GPS module can detect the coordinates of the location of the smart seal. In this test, the ESP32 microcontroller and the NEO-6M GPS module were used, which were first connected to a WiFi network as a data transmission medium. If the ESP32 microcontroller and the GPS module are connected to WiFi, the connected status will appear along with the IP Address, Netmask, and Gateway of the WiFi used.

GPS works to detect the distance from the determination of several satellites, through programming to find out the presence of GPS satellites at a certain time. The satellite will send information about the position and time in the form of radio signals. So that the signal can identify the location by determining the distance and length of time needed in the signal transmission process.

On the serial monitor that is used to display coordinate data from the location of the smart seal, first set the PORT to be used, namely COM 6 with a baud rate of 115200, which can indicate how fast the data will be sent via serial communication. The timestamp will display every process running on the serial monitor. In the serial monitor, two-dimensional coordinates are displayed to determine the distance from the smart seal in the form of longitude (latitude) and latitude (longitude). From detecting the longitude and latitude coordinates, the location of the smart seal can be known.

The test of sending coordinate point data for the NEO-6M GPS module is carried out by calculating the time interval for sending coordinate point data by the GPS module according to the data displayed on the serial monitor. The result of sending coordinate point data by this GPS module, data retrieval is carried out 50 times. The maximum time for sending coordinate point data by the GPS module is 2234 ms (millisecond) or 2.234 seconds. Meanwhile, the minimum time for sending coordinate point data by the GPS module is 1903 ms (millisecond) or 1,903 seconds with an average data transmission time of 2060 ms (millisecond) or 2,060 seconds. The GPS module's WiFi network strongly influences the time interval for sending coordinate point data. If there are obstacles or the WiFi network is disrupted, the process of sending or detecting coordinates by the GPS module will take a longer tim

Send Data to Web Service Test

The test of sending data from the ESP32 microcontroller to the database is carried out in a place with a significant and stable GPS signal network coverage so that the location detected by the GPS module is easy to read. This data transmission is done with a WiFi network connection. The IP on the ESP32 microcontroller must be the same and match the IP on the web service that is connected to the MySQL database. In this process, the POST method is to receive data from the ESP32 microcontroller to the MySQL database. Several factors affect the sending process, namely WiFi network and GPS signal. Both of these things can affect and hinder the data transmission process, so that the delivery time interval becomes longer. Therefore, a stable WiFi network and GPS signal is needed to be able to overcome this.

The test of sending data to the web service aims to determine the performance of the web service that is made to be able to realize the appropriate data communication. In this test, the average response time is obtained in each data transmission that is transmitted to the server in real time.

Testing this data transmission is done by calculating the time difference for each data that has been sent to the server in real-time. Data retrieval in this test is as much as 50 data within a specific time span. The results of testing the sending of smart seal data to the web service in a disconnected condition using the POST method show that the maximum time required for sending seal condition data to the server is 4000 ms (millisecond) or 4 seconds. Meanwhile, the minimum time for sending the data is 2000 ms (millisecond) or 2 seconds with an average delivery time of 2800 ms (millisecond) or 2.8 seconds.

The Result of Web Service PHP Test

This web service was created to make it easier to monitor the condition of the smart seal. The programming language used in making this web service is the PHP programming language, which is useful for creating a web service framework and making adapters as a liaison between databases, web services, and smart seals. The web service design is made using CSS and HTML languages to make the web service look more attractive. This web service has 6 widgets: home, seal location, graph, table, team, and contact us. For the location of the seal (maps) used in the web service, use the API Key from google maps so that it can always be updated according to the latest google maps. The data storage of this smart seal uses a MySQL database.

In addition, to connect the smart seal with the MySQL database, the POST method and the UPDATE function are used, whose program code is listed or written in a PHP file. The POST method is useful for receiving and sending data from the smart seal to the database and vice versa. Meanwhile, the UPDATE function is used to regulate if there is data that you want to change, so it doesn't interfere with other data.

In the web service that has been created, there are special pages for admins, interpreters and pages for users. The page display for the user is divided into 6 widgets, including home, seal location, seal graph, table, team and contact us. Each of these pages has its own function. The user who accesses the web service to be able to monitor the condition and location of the smart seal must log in by registering and registering first to be able to do or get login access as a user.

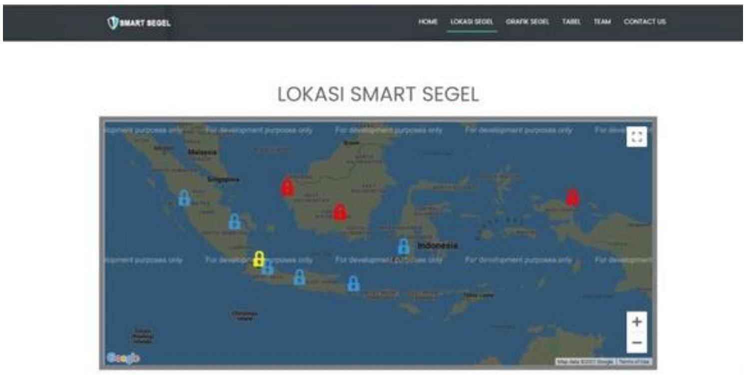

FIGURE 3. Smart Seal Location

In the seal location widget, the second page of the web service, it is created by using the API Key from google maps which then the location data of the smart seal will be stored in a MySQL database. In addition, on this page you can find out the condition of the smart seal according to its location, which is symbolized in the form of an image or a lock icon. There are three categories of smart seal conditions that can be distinguished by color, including:

a. Blue

The seal is in a connected condition, thus indicating that the seal is in good condition without any indication of breach or damage to the seal

b. Red

The red color on the padlock symbol indicates the condition that there is damage to the seal or an indication of breaking the seal as a form of violation of TMWE by irresponsible persons.

c. Yellow

A padlock with a yellow color indicates that the seal has been broken with the TMWE condition in the calibration process (calibrating or recalibrating).

FIGURE 4. Seal Condition Graph Widget

The seal graph widget displays the condition of each seal, divided into two conditions, namely the condition of the good seal and the condition of the damaged seal. In good seal condition, it is determined based on seal in connected condition. Meanwhile, in the case of a damaged seal, it is based on an indication of a breach in the seal, in the form of breaking the seal. In the graph, it can also be seen the number of TMWE and seals that can be detected according to the respective locations ofthe smart seals and TMWE.

No	Lokasi	Kondisi	Nama Penera	ID Penera
1	Jakarta	ditera	Rayhan Putra	A018053
2	Makassar	baik	Rizki Hidayat	A018004
3	Padang	baik	Kresna Andika	A018050
4	Pontianak	rusak	Nur Azizah	A018048
5	Manokwari	rusak	Iqbal Firadus	A106043
6	Bandung	baik	Rifqi Putra	A018028
7	Yogyakarta	baik	Gayuh Tentri	A018002
8	Bali	baik	Danang Wiji	A018007
9	Palangkaraya	rusak	Desfira Amalhayati	A018011
10	Palembang	baik	Cahya Kumara	A018080

FIGURE 5. Widget Tabel Smart Segel from System

The fourth user page, the smart seal table widget, contains information related to the smart seal information. These data are in the form of:

a. The Location of Lokasi *smart seal*

Shows the location of the presence of the smart seal and TMWE centrally based on the city of existence of the smart seal.

b. The condition of *smart seal*

Shows the current condition of the smart seal, to be able to detect immediately if there is an indication of a violation of the smart seal.

c. Name of Verificator

The identity of the marker is included with the aim of being able to find out information regarding the indicator that has been calibrated or recalibrated on the TMWE and is responsible for the seal that has been installed in the event of a problem.

d. Verificator ID

The calibration ID is required when caching or recalibrating the TMWE with the smart seal is carried out.

Data segel

No	Kota	Kondisi	Nama Penera	ID Penera	Opsi
1	Jakarta	ditera	Rayhan Putra	A018053	Edit | Hapus
2	Makassar	baik	Rizki Hidayat	A018004	Edit | Hapus
3	Padang	baik	Kresna Andika	A018050	Edit | Hapus
4	Pontianak	rusak	Nur Azizah	A018048	Edit | Hapus
5	Manokwari	rusak	Iqbal Firadus	A108043	Edit | Hapus
6	Bandung	baik	Rifqi Putra	A018028	Edit | Hapus
7	Yogyakarta	baik	Gayuh Tentri	A018002	Edit | Hapus
8	Bali	baik	Danang Wiji	A018007	Edit | Hapus
9	Palangkaraya	rusak	Desfira Amalhayati	A018011	Edit | Hapus
10	Palembang	baik	Cahya Kumara	A018080	Edit | Hapus

FIGURE 6. Admin Page

In addition to the user page, there is also an admin page that serves to display data from the smart seal database. The data is in the form of the location (city) of the smart seal, the current condition of the seal, the name of the indicator that performs the calibration on the TMWE and is responsible for the seal that has been installed and the ID of the indicator.

On this special admin page, the data related to the smart seal can be changed by the admin as needed by adding the option to delete or edit existing data. Admins can delete smart seal data and edit the data under certain conditions, such as during calibration or re-calibration. So the data will adjust the conditions in the event of a seal break due to the implementation of calibration and re-calibration activities.

Data segel

No	Kota	Kondisi	Nama Penera	ID Penera	Opsi
1	Jakarta	ditera	Rayhan Putra	A018053	Ditera |
2	Makassar	baik	Rizki Hidayat	A018004	Ditera |
3	Padang	baik	Kresna Andika	A018050	Ditera |
4	Pontianak	rusak	Nur Azizah	A018048	Ditera |
5	Manokwari	rusak	Iqbal Firadus	A108043	Ditera |
6	Bandung	baik	Rifqi Putra	A018028	Ditera |
7	Yogyakarta	baik	Gayuh Tentri	A018002	Ditera |
8	Bali	baik	Danang Wiji	A018007	Ditera |
9	Palangkaraya	rusak	Desfira Amalhayati	A018011	Ditera |
10	Palembang	baik	Cahya Kumara	A018080	Ditera |

FIGURE 7. Verification Page.

On the publisher-only page, it can only be accessed by the publisher with permission from the admin. This indicator access is useful for caching or recalibrating TMWE by using a smart seal for security. Penera (Verificator) can log in with the account given by the admin, and press the "Ditera" option on the widget display or existing page according to TMWE and the location to be calibrated and recalibrated. This process is needed so that the display on the map, namely the color of the seal, will adjust to the condition, which changes to yellow because the calibration process is being carried out on the TMWE and the smart seal.

CONCLUSION

Service of data transmission mechanism for smart seal security, using data transmission media from smart seal prototype to web service. The WiFi network as an implementation of IoT (Internet of Things) with ESP32 microcontroller. In the process of merging or integrating data from the smart seal prototype with the MySQL database using a WiFi network which is used as a data transmission medium by utilizing the IP Address of the WiFi network. After the seal condition data has sent, the data will be received by the database and will be processed according to the program code to be displayed in the web service that has been created. The interface is in the form of a graphical display that is directly related to the user. The interface is made in the form of a web service that serves to connect the user with the operating system. This interface contains data from a MySQL database connected to the smart seal prototype, so it can automatically respond to the web service if there is a change in the data.

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REFERENCES

[1] H. Hindersah *et al.*, "Prototype Development of Single Phase Prepaid," *International Conference on Electrical Engineering and Informatics*, Bandung: Institute of Electrical and Electronics Engineers, pp. 1-6, 2011.

[2] I. D. Syahwir *et al.*, "Internet Of Things Of Electronic Seal Base On Gprs Short Message Service And Thingspeak Spektra," *Jurnal Fisika Dan Aplikasinya*, vol. 4, no. 3, pp. 125-132, 2019.

[3] A. Imran and M. Rasul, "Pengembangan Tempat Sampah Pintar Menggunakan Esp32," *Jurnal Media Elektrik*, vol. 17, no. 2, pp. 2721-9100, 2020.

[4] Kho Dickson, "Pengertian transistor dan Jenis-jenis Transistor," *Undang-Undang Republik Indonesia No. 2 Tahun 1981*, Metrologi Legal Jakarta : Author, 1981.

[5] L. Lancor and S. Katha, "Analyzing PHP frameworks for use in a project-based software engineering course," *44th ACM technical symposium on Computer science education (SIGCSE '13)*, New York: Association for Computing Machinery, pp. 1-6, 2013.

[6] Menteri Perdagangan, "Peraturan Menteri Perdagangan Republik Indonesia Nomor 26/M DAG/PER/5/2017, Tentang Pengawasan Metrologi Legal," Jakarta, Indonesia, 2018.

[7] K. Maurya, M. Singh and N. Jain, "Real Time Vehicle Tracking System using GSM and GPS Technology-An Anti-theft Tracking System," *International Journal of Electronics and Computer Science Engineering*, vol. 2, no. 3, pp. 1103-1107, 2012.

[8] M. S. Novendri, A. Saputra and C. E. Firman, "Aplikasi Inventaris Barang Pada MTS Nurul Islam Dumai Menggunakan PHP Dan MySQL," *Lentera Dumai*, vol. 10, no. 2, pp. 46-57, 2019.

[9] N. Nurseitov et al., "Comparison of JSON and XML Data Interchange Formats: A Case Study," Bozeman, Montana, United States of America, 2009.

[10] C. Platt, "Encyclopedia of Electronic Components," *Power Sources & Conversion*, San Fransisco: O'Reilly Media, vol. 1, 2012.

[11] C. Platt and F. Jansson, "Encyclopedia of Electronic Components," *Signal Processing*, San Fransisco: Maker Media, vol. 2, 2014.

[12] C. Platt and F. Jansson, "Encyclopedia of Electronic Components," *Sensors for Location*, San Fransisco: Maker Media, vol. 3, 2016.