The International Journal of Engineering and Science (IJES)
|| Volume || 10 || Issue || 5 || Series I || Pages || PP 06-14|| 2021 ||
ISSN (e): 2319-1813 ISSN (p): 20-24-1805

Implementation of a Battery Charge Monitoring System on Internet of Things (IoT) Based Transportable Devices

Ade Kurniawan[1], Dedy Suryadi[2], Purwoharjono[3],
Redi R. Yacoub[4], Fitri Imansyah[5]
Department of Electrical Engineering, Tanjungpura University[1,2,3,4,5]
Corresponding Author: Ade Kurniawan

--- ***ABSTRACT***---

The Transportable Radio Frequency Monitoring System (RFMS) is a radio frequency or surveillance system installed at 64 well-known SMFR stations in the territory of Indonesia, which have pioneering airports and are controlled by 24 Technical Implementing Units (UPT) of the Ministry of Communication and Informatics. In this implementation, research was carried out to create a real time monitoring system for currents, voltages and power through a remote monitoring system. Therefore, the efforts made for this problem designed a monitoring system that can be accessed from the battery used to see the current, voltage and power parameters measured on the system with the sensor installed and transmit the data using internet communication media and the Blynk application as a display information so that battery performance can be properly maintained and monitored. In this study, testing was carried out with several testing stages, namely the power supply system that uses 1 battery where the calculation results show the battery capacity is 12V 10Ah and the load of the led light is 18w, the current increases = 1.5 A with a battery discharge duration of ± 7 hours, the results of the test with good battery conditions, it shows the discharge capacity of the battery with the same load for about ± 6 hours. Whereas for the 3-battery power supply system has a total test effect of ± 21 hours of recharging the battery, so that this system runs by recharging the battery, which occurs this system will be able to serve the load throughout the day by filling each battery that can be seen properly so that the time battery usage will be maximized because the battery capacity is maintained <20% or less than 10.9V.

***Key Words** : Internet Of Things (IoT), Monitoring, Transportable*

Date of Submission: 28-04-2021 Date of Acceptance: 12-05-2021

I. PRELIMINARY

Electrical energy is one of the main needs required in various activities within the community, industry and government where quality needs to be maintained. This quality is important to know because it can affect the performance and service life of the equipment used. Among the factors that affect the quality of electrical energy are voltage, current, and power in the system [1].

The amount of electricity should be maintained within the conditions or permissible standard limit. To find out, it is necessary to have a tool that can monitor the amount of electricity. Currently, monitoring of electrical quantities such as voltage, current, and power can be done by installing measuring instruments on the power supply of the equipment, one of which is the Transportable radio frequency monitoring system (SMFR) [1].

In this research, a real-time current, voltage and power monitoring system will be implemented through a remote control that has been provided so that the Class II Pontianak Radio Frequency Spectrum Monitoring Center can use it properly without the help of others, monitoring will provide information on the value of currents, voltages and the power will be displayed via the LCD (Liquid Crystal Display) and can be seen directly on the smartphone. Subsequently, it is necessary to make a prototype to monitor and store real-time electrical quantity data. Besides being able to provide information on the amount of electricity it can also be used as a reference for electrical power system analysis activities [1]

II. LITERATURE REVIEW

2.1. State of The Art Review

Research that has been conducted by several previous researchers regarding the volatage profile is as follows:

Afrizal Fitriandi [3], designing a microcontroller-based current and voltage monitoring device using an SMS gateway. Conduct research with a microcontroller-based current and voltage monitoring system with an

SMS gateway to simplify monitoring of currents and voltages. The current and voltage will be monitored periodically via the telecommunication network via SMS every 5 minutes.

Yohana Kristinawati [4], Implementation of Battery Capacity Monitoring Module in Embedded Devices. In its implementation, the module uses a shunt resistor to obtain the amount of voltage drop, then by using Ohm's Law, the current flowing can be obtained. When the current is known, the battery capacity can be calculated. Value processing was performed using an Arduino nano microcontroller. Then the battery capacity and current information is displayed on the 16X2 LCD. The conclusion is that the module can measure the current flowing in embedded devices and the module can calculate the battery capacity used by embedded devices and has a precision level of 94.56% in measuring battery capacity.

Didik Sukoco [5], design a battery control and monitoring system with a numerical algorithm for renewable electrical energy sources. Designing and building an energy control by integrating the battery system mathematical modeling. Furthermore, for the work of the system can be improved by carrying out the characteristics of the energy stored in the battery so that the battery can always be monitored, this is taken by research with the characteristics of the battery in a damaged and normal condition.

The author develops research on the implementation of a battery power supply monitoring system on IoT-based transportable devices, which from this research is expected to be able to remotely monitor the transportable battery power supply. In addition, the system can maintain battery life.

2.2. UPS (Uninterruptible Power Supply) [6]

The static UPS system is a circuit that functions to ensure the continuity of the power supply and protect the load from disturbances in the quality of the power on the main power supply. This can be achieved by using a solid-state circuit that uses batteries or kinetic energy as an alternative energy source.

2.3. Energy Storage System (Battery) [5][7]

The battery is like a storage tank for electrical energy. Then the electric charge flows into the battery through the cable, which is then converted into chemical energy stored in a few days.

When the battery is charged (charge), electrical energy is stored as chemical energy in the cell and when the battery is used (discharge), the stored chemical energy is taken and converted into electrical energy..

2.4. Current Sensor ACS758 [6]

ACS758 current sensor provides an economical and precise solution for AC or DC for current sensors. Typical applications include motor control, load detection, power supply and DC-to-DC converter control, inverter control, and overcurrent fault detection.

2.5. Voltage Sensor [11]

The working principle voltage sensor is based on the principle of suppression of resistance, and can make the input voltage reduce up to 5 times the original voltage.

2.6. Internet Of Things (IoT)

Internet of Things (IoT) is a concept that uses the internet as the main infrastructure network that connects certain objects [17]. In this case IoT can also be interpreted as the internet that connects things, where things here mean information such as meta data [18].

2.7. Monitoring Application (Blynk App) [12]

Blynk is a service provider in the form of a platform for Mobile OS applications (Android and iOS) which is useful as a component that communicates between microcontrollers and OS Mobile (smartphones and tablets), to create an interface that works in IoT, which can be controlled from anywhere without using cables. (wireless). Blynk as shown in Figure 2.14, was made by Pasha Baiborodin in 2015, and was launched for the first time on the project list on the site www.kickstarter.com which finally succeeded in the market (Seneviratne, 2018).

2.8. Transportable Radio Frequency Monitoring System (SMFR) [14]

The Transportable Radio Frequency Monitoring System (SMFR) is a radio frequency monitoring or monitoring system installed in 64 Transportable Stations spread across Indonesia which have pioneering airports and are controlled by 24 Technical Implementing Units (UPT) of the Ministry of Communication and Informatics as control stations or control center. The West Kalimantan region has 3 transportable stations, namely in the Sintang District, Kapuas Hulu Regency and Ketapang Regency with the UPT Pontianak control station installed at the Pontianak Class II Radio Frequency Spectrum Monitoring Office since 2016 [2]

III. METHODS

3.1. Materials and Tools

3.1.1 Hardware Design *(Hardware)*

A microcontroller is a digital electronic device that has input and output as well as control with a program that can be written and deleted in a special way. In other words, the microcontroller works by writing and reading data in analog and digital form.

3.1.2 The Utilize of Arduino Mega2560 Input Output Pin

The Arduino Mega 2560 has 54 digital pins that can be used as input or output. In accordance with the interface circuit connected to the Arduino Mega.

3.1.3 Current Sensor Circuit

ACS758 current sensor provides an economical and precise solution for AC or DC for current sensors. Typical applications include motor control, load detection, power supply and dc-to-dc converters, inverter control, and overcurrent fault detection.

3.1.4 Voltage Sensor Circuit

The voltage sensor functions to read the voltage value of a circuit. Arduino can read the voltage value by using an analog pin. If the read voltage distance is between 0 -5 V, you can directly use the analog pin, whereas if the read voltage range is> 5 V you must use an additional circuit, namely the voltage divider because Arduino pins work at max 5 V DC.

3.1.5 Interface Circuit LCD *(Liquid Crystal Display)*

LCD (liquid crystal display) is a device that functions as a display medium by utilizing liquid crystals as the main display object. LCD is of course very widely used for various purposes such as television electronic media, calculators, or even computer screens.

3.1.6 Battery Charger Relay Switch Circuit

Charger voltage is usually 110% to 115% of the nominal battery voltage. If the battery is 12Volts, the charger voltage must range from 13.2 to 13.8Volts. If it is more, there will be over voltage and over charge. If we use the power supply as a charger, the voltage power supply (usually 12Volt) is only able to charge the battery (Accu) at 100% of the nominal battery voltage and usually after being charged and used the battery will run out quickly because it is considered not full.

3.1.7 Arduino - Nodemcu Serial Communication Series

NodeMCU is an IoT platform that is open source. It consists of hardware in the form of a system on chip ESP8266 from the ESP8266 made by Esperessif System. NodeMCU can be analogized as an Arduino board connected to the ESP8622. NodeMCU has packaged the ESP8266 into a board that has been integrated with various features such as a microcontroller and access to wifi as well as a communication chip in the form of USB to serial.

3.2. Whole System Circuit Design

The whole series of systems designed with the Arduino Mega 2560 controller / controller is equipped with an LCD display (Liquid Crystal Display) as a display of current sensor parameters and 4 sensors are used, where 3 sensors are used to monitor battery charging and 1 sensor is used to find out the amount of power in the load. In addition, a digital voltage and current display module is also used which also makes it easier for users to monitor the value of the current and voltage on the battery or battery power, this system is also equipped with an IoT (Internet Of Things) coupler, which is communication with smartphones via the Android application Blynk.

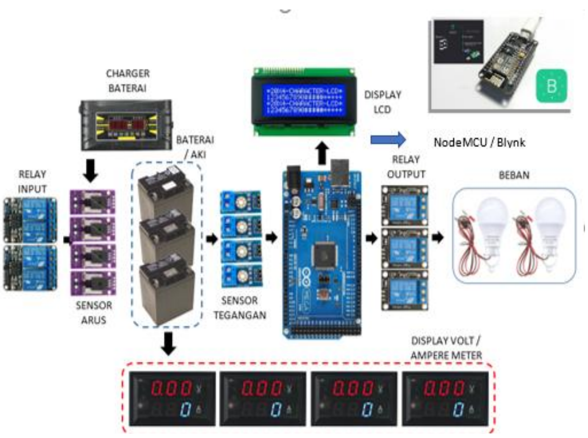

Figure 1 System hardware circuit

3.3.1. Flow Diagram System

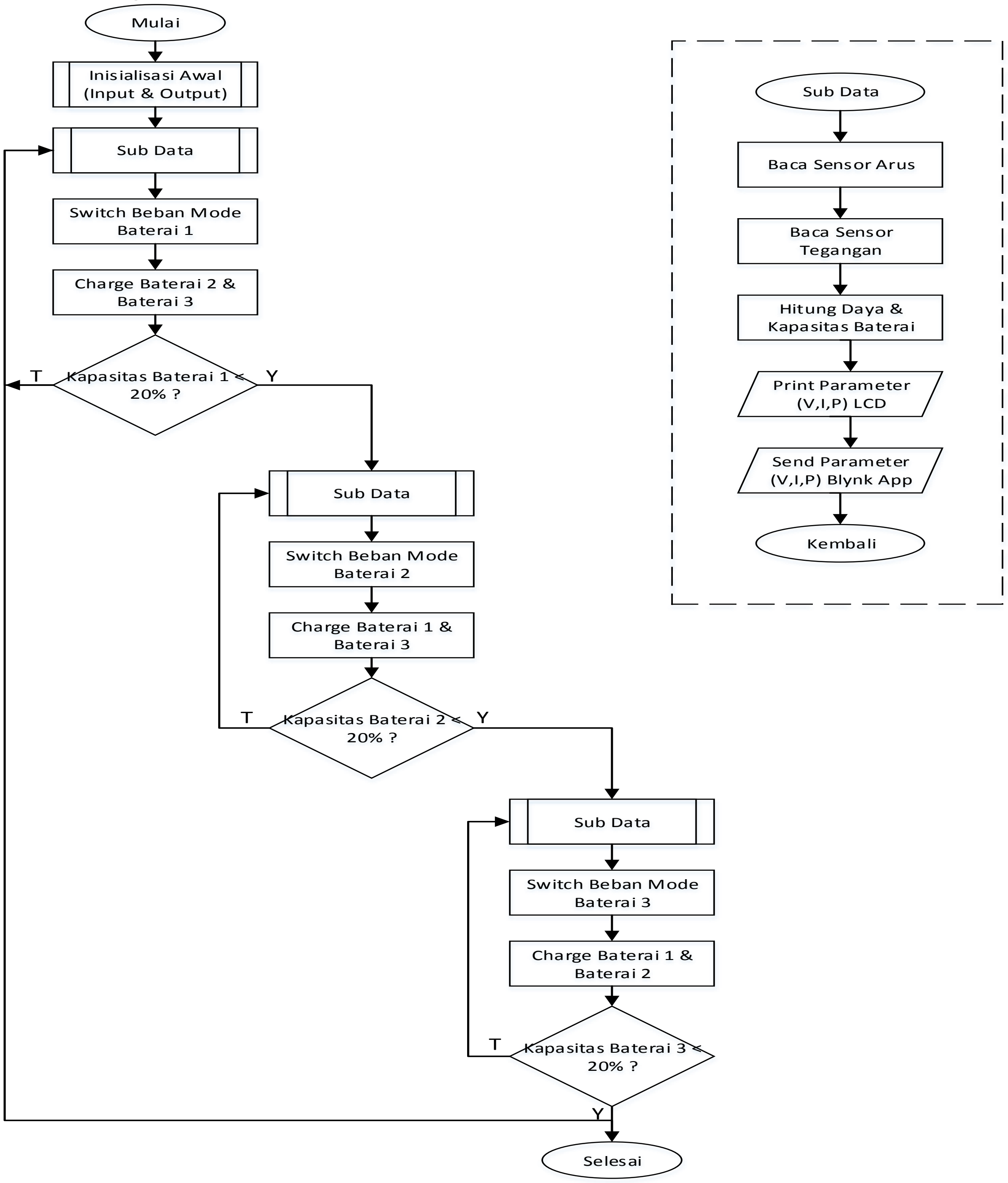

Figure 2 Flow diagram of the system

3.3. Blynk App Interface Design

Blynk is an application for iOS and Android OS to control Arduino, nodeMCU, raspberry Pi and the like over the internet. This application can be used to control hardware devices, display sensor data, store data, visualize, and others. The blynk application has 3 main components, namely applications, servers, and libraries. Blynk server functions to handle all communication between smartphones and hardware. The widgets available on the blynk include Button, Value Display, History Graph, Twitter, and Email. Blynk is not tied to several types of microcontrollers but must be supported by the selected hardware. NodeMCU is controlled by the internet via Wi-Fi, the ESP8266 chip, blynk will be made on line and ready for the internet of things.

IV. DISCUSSIONS

4.1. Testing Prototype One Battery Transportable Power Supply

Transportable Radio Frequency Monitoring System (SMFR) equipment works in frequency monitoring where this device consists of the main equipment, namely the receiving antenna and the Fixed Monitoring Unit (FMU) module. In addition, there are also supporting devices such as Uninterruptible Power Supply (UPS), proxy routers, internet modems and CCTV DVRs that are used to view the security and condition of transportable devices at station locations. Therefore, a "battery power supply monitoring system for IoT-based portable devices" is designed which will help to see the parameters of the UPS so that the devices used can be managed properly in terms of hardware such as batteries.

Figure 3 Prototype monitoring of 1 battery power

To find out the characteristics of the battery discharge system used, a monitoring prototype was made using one battery with a capacity of 10 A, with it the ability of the battery to serve the load, namely in the form of a DC 12V 20W LED lamp, obtained characteristic data from the specifications used such as in figure 3.

4.2. Testing One Battery Transportable Power Supply

To determine the characteristics of the system, the test was carried out using a single battery discharge with a specification of 12 V in 10 Ah with a constant load of 18 W DC LED lamps.

Where :

$I = P / V$

$= 18\ W / 12\ V = \mathbf{1,5\ A}$

Battery usage time = 10 Ah / 1,5 A = 6,67 hour $\approx$ **7 Hours**

From the calculation of the capacity of the battery power in time units, the calculation shows the duration of 1 battery usage for approximately 7 hours. And the following is a graph of the analysis results from the Blynk app which shows a graph of the voltage drop periodically. Because the data retrieval interval is carried out with parameter updates, the graph of the voltage drop that occurs will be smoother.

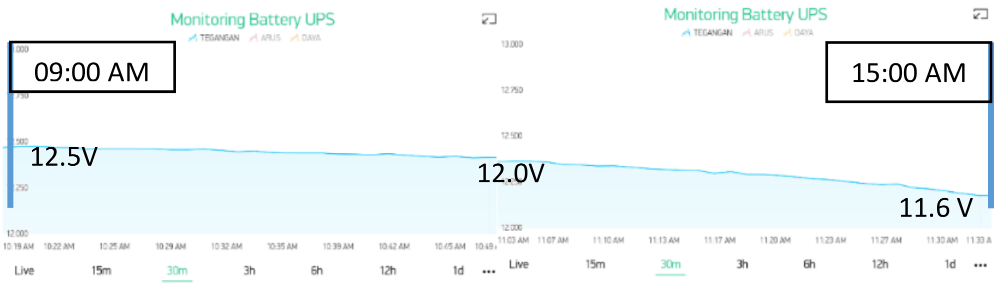

Figure 4 Graph of the battery voltage

Source: Blynk app

From the voltage graph in Figure 4, the test results with a static load are 18-Watt LED lights, so the duration of battery use starts from 09.00 WIB to 15.00 WIB with an initial voltage of 13.0 V and a final voltage of 11.6 V, so the total battery usage is less more for 6 Hours.

4.3. Testing of the Three Battery Power Supply System

After testing the data supply system using 1 battery, the test data on battery usage on a 12 V 22 W LED light load for one battery has a duration of about 6 hours, therefore, the battery power supply monitoring system on IoT-based portable devices is designed using 3 units. battery as shown in Figure 5 can improve battery usage time, because the battery replacement system is used sequentially or alternately.

Figure 5 Prototype 3 battery power supply

Through the calculation of the total capacity of the battery used, it is assumed, 12 V 10 AH battery, 12 V 22 W LED lamp load, the total time duration if using 3 batteries is 6 hours x 3 batteries = 18 hours. This condition occurs if while serving the load no charging is done, if the battery is recharged regularly, the system is expected to run all day long.

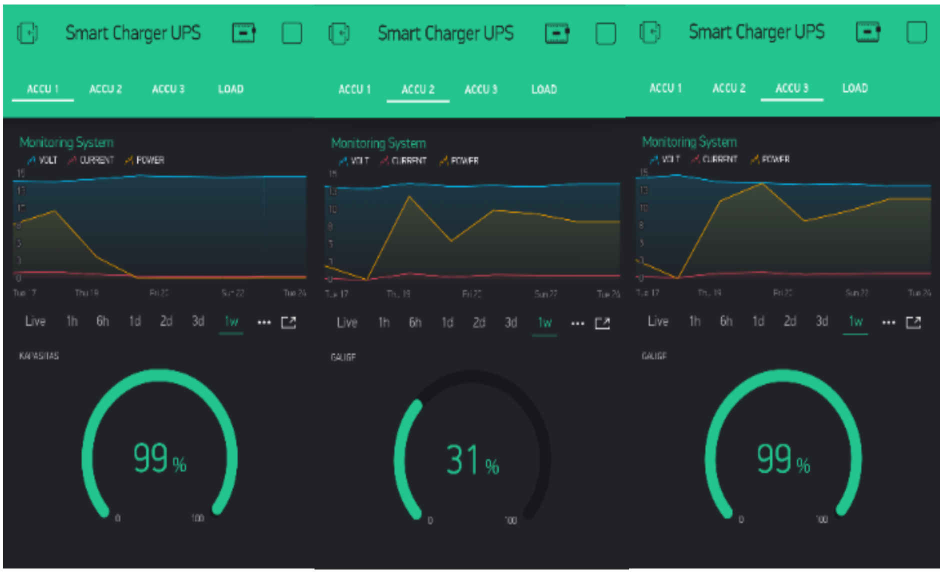

Figure 6 Graph of 3 battery system power supply

Source: Blynk app

As in Figure 6 the graph of the results of the 3 battery power test for one week where as shown above the condition of the battery used is battery 2 with a capacity of about 30%, for battery 1 and battery 3 the condition is in charging, the capacity indicator shows 99%.

4.4. Testing of Battery Charging and Discharging Transition Times

Testing the transition time for charging and discharging this battery aims to determine the characteristics of the battery used with a constant load, namely the 18 W DC LED lamp, battery discharge 1 in the blynk application can be seen in Figure 7, a graphic display where battery discharge starts at 09.00 AM with initial voltage 14.8 Volt. Then at 01.00 PM the battery voltage 1 drops to 11.8 volts, meaning that there is a voltage drop to less than 20%, so the battery discharge time 1 is ± 4 hours.

Figure 7 Graph of discharging battery capacity 1

Source: Blynk app

Furthermore, the test is carried out with battery 2 with the same load or constant load current, to see the time of use of battery 2 can be seen in the Blynk application as in testing battery one in Figure 8, a period is taken when the battery capacity is full 99% until the battery capacity is less than 20%.

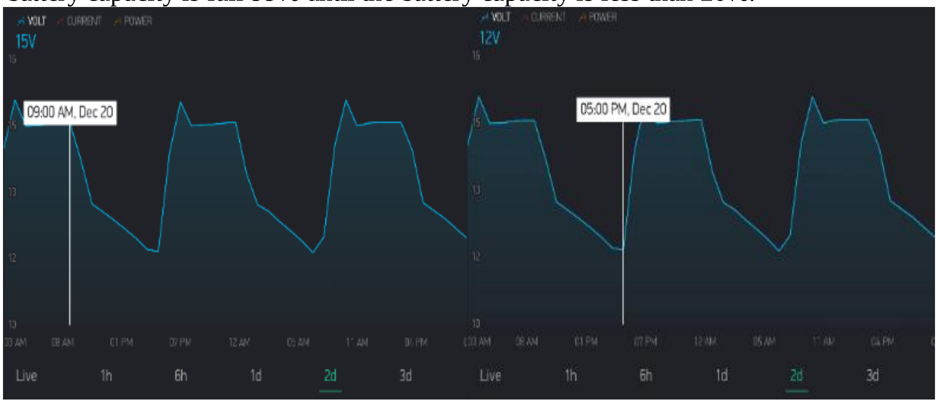

Figure 8 Graph of discharging battery capacity 2

Source: Blynk app

Next, the same thing was tested on battery 3 by looking at the graph of tools in the Blynk application, the results were shown in Figure 4.15 with an initial voltage of 14.8 Volts and a final voltage of 11.2 Volts or less than 20% obtained from the results of the battery duration graph 3. ± up to 9 hours as shown in Figure 9.

Figure 9 Graph of discharging battery capacity 3

Source: Blynk app

From the testing of 3 batteries that have been carried out, it is found that the test results of battery 1 against the load have a duration of ± 4 hours, a battery of 2 ± 8 hours and a battery of 3 ± 9 hours against the same load power.

Table 1 Comparison of calculation and comparison data

Battery / Accu	Capacity	Calculation Results	Testing Results
Batt 1	10 Ah	7 hrs	4 hrs
Batt 2	10 Ah	7 hrs	8 hrs
Batt 3	10 Ah	7 hrs	9 hrs

From table 2 it can be seen that the three batteries used in the calculation results of each battery are able to withstand a load with an average time of 7 hours per battery, but in the test results there is a time difference in each battery where the first battery is only able to withstand the load with time 4 hours, the second battery 8 hours and the third battery 9 hours.

The total usage time of the three batteries in the test = **4 hours + 8 hours + 9 hours = 21 hours.** Testing the three batteries to serve the maximum load without charging the battery can reach 21 hours, so that if the charging system is running well, this system can serve the load throughout the day.

From the test data, it can be analyzed and compared between systems using one battery and three batteries by converting table data into graphs with data retrieval at 30 minute intervals. In testing the power supply system that uses 1 battery, the test is carried out without recharging the battery, the test results begin at 09.00 am, while the load used is between testing the system using 1 battery and the system using the same 3 batteries, namely the 18 watt DC LED light.

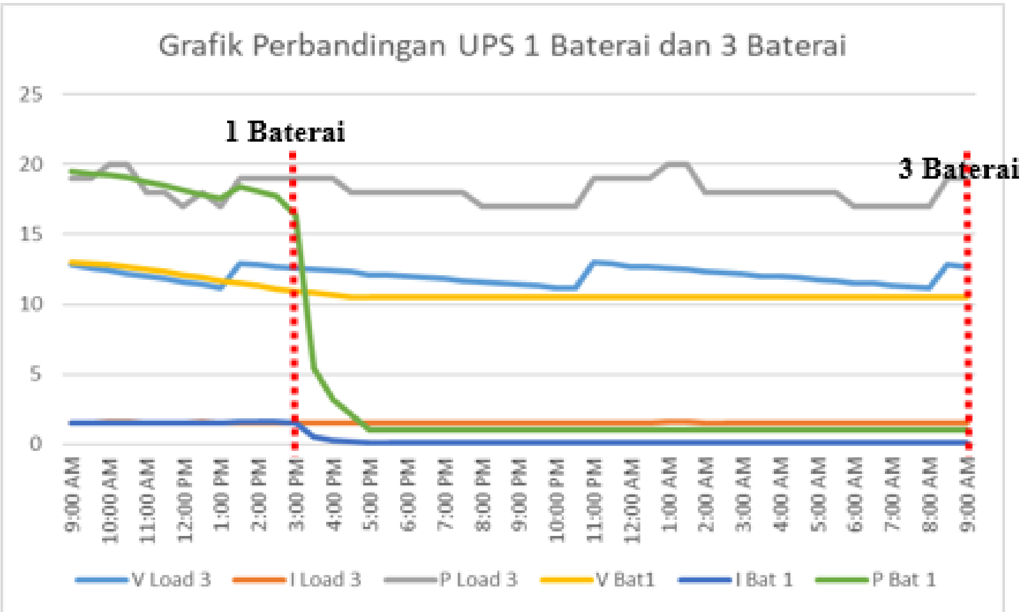

Figure 10 Comparison graph of 1 battery and 3 battery UPS system
Source: processed data from testing

From Figure 10 it can be seen a very significant comparison if using a single battery system, the power supply system is only able to serve the load for 6 hours later to maintain battery efficiency, when the battery capacity is <20% or the battery voltage is less than 11 volts, the load installed is cut so that the battery doesn't drop.

If only one battery is used, the system is unable to meet the load requirements due to limited battery capacity, therefore the system developed uses 3 batteries which are used alternately with the work system when one battery is used to serve the load, the other battery will be charged immediately. so that every change of battery switch is always in full condition, so that the total time generated by testing 3 batteries can reach 21 hours, meaning that if the system gets a supply that will recharge the battery used, the system can be used throughout the day by considering the minimum battery capacity, so that the battery not forced until it is empty.

V. CONCLUSIONS

5.1. Conclusion

From the results of the research that has been done, the following conclusions have been drawn:

a) From the results of tests carried out on the 3 battery power supply monitoring system using IoT, the system can work properly, namely adjusting the energy source or the power supply battery alternately according to the sequence set in the program.
b) The system is made to be able to determine the condition of the battery used by looking at the characteristics of the transition graph of the voltage, current, power and capacity of the switch that regulates the transfer of the battery power supply source.
c) This system can also be an alternative control that can efficiently manage battery usage because every use and charging is monitored on the smartphone application.

5.2. Suggestion

The suggestions that can be given for this research are as follows:

a) The power supply system designed for the removal of batteries 1, 2 and 3 should be carried out using an electronic switch such as a mosfet or SSR (Solid State Relay) to be more efficient and reduce current shocks that occur during battery transfer.
b) Future development is expected to increase the number of batteries used as a power supply source and controllers that already have clock speeds above 16 MHz, in order to read current and voltage sensors in a more real time and reduce reading errors on the sensors used.
c) The IoT blynk application used is still open source, so in the future an application can be made specifically designed to monitor the power supply system on this device.

REFERENCES

[1]. N. AMARO, "Electricity Monitoring System with IoT (Internet of Things) Technology)," University of Bandar Lampung, pp. 1–52, 2017.
[2]. Decree of the Minister of Communication and Information of the Republic of Indonesia No. 518-2016 concerning "Development of Radio Frequency Monitoring System Infrastructure".
[3]. A. Fitriandi, E. Komalasari, and H. Gusmedi, "Design of Microcontroller-Based Current and Voltage Monitoring Tools with SMS Gateway," vol. 10, no. 2, 2016.
[4]. Y. Kristinawati, S. R. Akbar, and R. Maulana, "Implementation of Battery Capacity Monitoring Module in Embedded Devices," vol. 2, no. 10, pp. 3210–3219, 2018.
[5]. Didik Sukoco, Design of Battery Control and Monitoring Systems Using Numerical Algorithms for Renewable Electrical Energy Sources, Master of Electrical Engineering, Faculty of Engineering, University of Indonesia, Depok, June 2012.
[6]. Digital Engineering Library, Uninterruptible Power Supplies (UPS) and Standby Power Handbook (McGraw-Hill, 2004), p 141-221. Retrieved November 21, 2007 from the department of electrical engineering website. www.ee.ui.ac.id/lib
[7]. D. Casini, and G. Marola., Solar batteray charge for NiMH batteries, International Symposium on Power Electronics, Electrical Drives, Automation and Motion, 2008.
[8]. Toshiba International Corp, "1400XL plus series UPS service manual", Houston, 1998.
[9]. Jerry C Whitaker, AC Power Systems Handbook Third Edition (California: Morgan Hill, 2007), p 136 – 216.
[10]. Alfizeri, Fadhli Palaha, Testing Prototype Home Installation Using ACS 758 Based on Arduino, Journal of Science and Technology STT Pekanbaru, 2017.
[11]. Hotnida Sirait, Design of Automatic Water Pump Regulator at Tandon Based on Atmega16 Microcontroller, Medan State Polytechnic Electrical Engineering, 2015.
[12]. Shaquille Achmad, Design of Monitoring Equipment for Infusion Fluid Based on Drop Rate and Volume of Infusion Based on Nodemcu Esp 8266, Faculty of Engineering, University of Lampung. Bandar Lampung, 2019.
[13]. Structure and Workings of Lead-Acid Battery Accu - http://VITTAQ.com (Image of Battery).
[14]. Yourdan, Evaluation of Infrastructure Utilization of Radio Frequency Spectrum Monitoring Equipment in Padang, Center for Research and Development of Resources and Equipment of Post and Information Technology, Jakarta, November 2013.
[15]. Sulistiyo, F, (2008), Management of the Monitoring System in the context of Control and Regulation of the National Radio Frequency. Retrieved March 12.
[16]. Ministry of Communication and Informatics of the Republic of Indonesia, Organization and Administration of Telecommunication and Informatics Financing Provider and Management Center, Jakarta, DKI Jakarta, Indonesia: Kemkominfo, 2011.
[17]. Internet of things: Vision, applications and research challenges by Miorandi, D., Sicari, S., De Pellegrini, F., & Chlamtac, I, 2012.
[18]. Internet of Things as a Methodological Concept by Bari, N., Mani, G., & Berkovich, S, 2013.
[19]. Principle Application and Vision in Internet of Things (IoT) by Hallaj Asghar, M., Mohammadzadeh, N., & Negi, A, 2015.

Ade Kurniawan, et. al. "Implementation of a Battery Charge Monitoring System on Internet of Things (IoT) Based Transportable Devices." *The International Journal of Engineering and Science (IJES)*, 10(05), (2021): pp. 06-14.