

IoT-based Prototype Design of PT PLN (Persero) UP3 Pasuruan's Post-Paid Customers' Temporary Electricity Circuit Breaker

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ABSTRACT

Objective: This study addresses the issue of delinquent customer payment behavior, which negatively affects the sustainability of electricity distribution and often necessitates temporary power disconnections by utility providers. **Method:** A research and development (R&D) approach was employed to design and implement a mobile disconnection system using an **Arduino Uno microcontroller**, **HC-05 Bluetooth module**, and an **Android-based Bluetooth Controller**. **Results:** Testing demonstrated that the HC-05 module provided an effective connectivity range of up to **4 meters**, with an average **0.8-second delay** between command transmission from the Android application and execution by the Arduino Uno to cut off electricity. **Novelty:** The developed IoT-based voltage breaker application significantly improves operational efficiency and service responsiveness for utility officers in handling late-paying customers, thereby enhancing overall utility management and sustainability.

INTRODUCTION

PT PLN (Persero) is the only State-Owned Enterprise (BUMN) that has specialization in sector electricity as well as functioning as Holder of Electricity Business Authority (PKUK) [1]. Responsibility PT PLN (Persero)' s responsibility is provision energy quality electricity for sufficient community needs and give maximum service. One of the services provided by PT PLN (Persero) are usage electricity post paid by consumers, which allows they for use power electricity more formerly before consumer is at the stage payment [2]. In addition, customers are also required to for pay cost excess risk if consumer through the deadline payment. Each month, PLN carries out data collection meter, do calculation, sending bill, and if consumer late pay, PLN will do termination connection electricity [3], [4]. In November 2022, PT. PLN (Persero) UP3 Pasuruan take notes that as many as 121,751 customers in its coverage area has in arrears payment amounting to 12 billion. Arrears the is accumulation from various group customers, including House household, social, and industrial. The size arrears This will influence PLN's income and impact on increasing performance company That alone [5], [6]. Therefore that, it is necessary existence device breaker temporary flow electricity from PLN which can become solution from previous customers termination via MCB on the KWH meter frequently There is connection own (manual) from party customers / consumers. The devices created in study This is A prototype.

A number of study previously has done like Sukandar Sawidin (2022) where researchers designing A system equipment electricity that can controlled use application Connected Android Voice Controller with bluetooth for activate or disable device

electronic in accordance with the command that has been programmed [7].

Study from Nano Sudin (2020), researcher designing A system controller light House based Arduino Uno microcontroller that allows users for turn on or turn off lights in the house they via smartphone using connected technology Bluetooth. This tool Work with use connection Bluetooth for control light House until distance maximum 16m without obstacle, or 9m if there is barrier like wall House or similar [8].

Study from Muhammad Agung Aditya (2019) regarding system for control as well as monitor condition House use module bluetooth HC-05 and Arduino Uno microcontroller where tool connected with network wireless for monitor condition House use Bluetooth network makes it easier use with device smartphone [9].

Study final from Muksin Hi. Abdullah (2019) designed A system control light electricity that utilizes Microcontroller ATmega 8535, relay, remote, and light in the project. Operational methods control light This involving use of remote control for activate or turn off connected lights with relay. This remote control connected with receiver on the microcontroller, where the emphasis the "O" button will turn on lights, while emphasis the "X" button will turn it off through system control that has been prepared [10].

Study moment This use Arduino Uno R3 microcontroller as center processing order Because more practical and affordable. For do monitoring and control, researchers utilise module communication wireless sensor network Bluetooth Low Energy (BLE) which will be connected with smartphone via application Android Bluetooth Controller [11], [12]. Disconnection scheme network utilizing the connected relay and MCB with a KWH meter customers can seen and decided by the officer in a way directly [13], [14].

RESEARCH METHOD

Study utilise method research and development with do testing effectiveness tool through various type experimentation, improvement, and finalization tools to overcome problems faced and achieved objective end Where product functioning in accordance with objective research [15]. Stages in method research and development is identification problem (1); study bibliography (2); design (3); testing (4); improvement (5); and implementation (6).

A. Block diagram

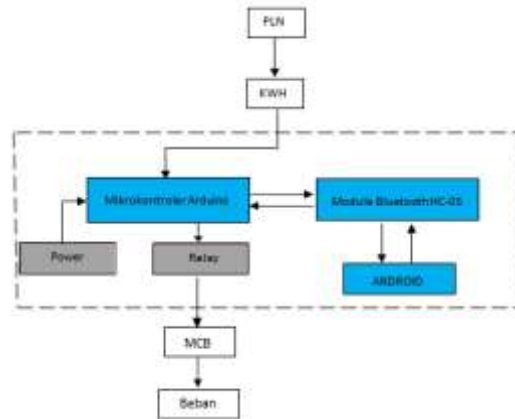


Figure 1. Block Diagram

Block diagram begins with source input electricity from the connected PLN to the KWH meter. After that, the Arduino Uno microcontroller, powered by a 5V power supply, is connected with *smartphone* via Bluetooth module HC-05 as control termination flow electricity with relay and MCB as output to load / flow electricity customer.

B. Flow chart

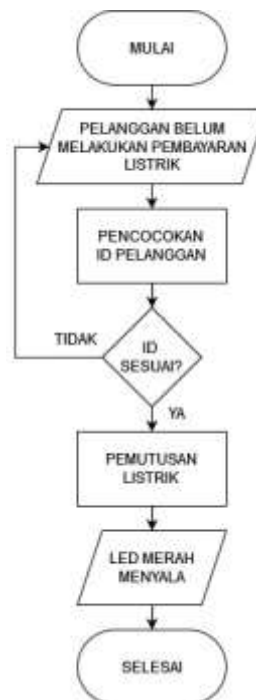


Figure 2. Flowchart

Flow diagram started moment officer know existence late customers do payment electricity to PLN. The next process, the officer do customer ID matching. If appropriate, then officer will do termination flow electricity represented with a red LED on the prototype device, until late customers pay pay off his responsibility.

C. Wiring diagram

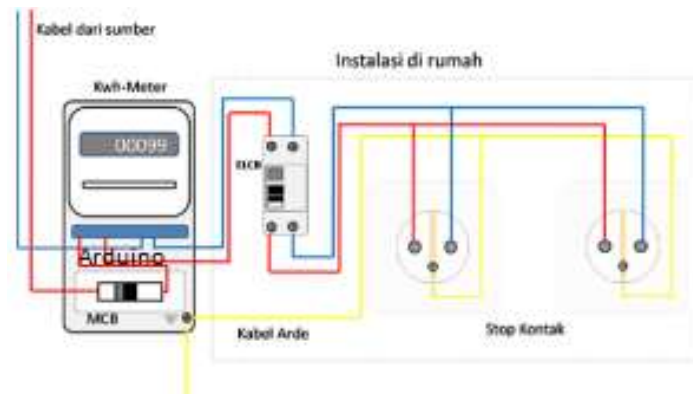


Figure 3. Wiring Diagram

As seen in the wiring diagram above, the cable phase from colored PLN sources red connected with Arduino Uno, MCB, and relay which will later will used by officers For do termination flow electricity to late customers pay bill.

RESULTS AND DISCUSSION

A. Realization results tool



Figure 4. Results of Tool Realization

Realization tool as seen in the image above show device prototype view breaker flow PLN electricity where you can see the KWH meter underneath there is an MCB, Arduino Uno microcontroller, and HC-05 Bluetooth module. After that there is connected fuse to 220V lamp.

B. Testing connectivity Bluetooth

Testing Bluetooth connectivity is established for test capability HC-05 module as connector between device breaker with *smartphone* with variation range different distances. The application used in testing This is *Android Bluetooth Controller* that can downloaded for free by users.

Table 1. Testing Bluetooth Connectivity

Testing to -	Distance	Connection Smartphone
1	30cm	Connected
2	50cm	Connected
3	100cm	Connected
4	150cm	Connected
5	200cm	Connected
6	250cm	Connected
7	300cm	Connected
8	350cm	Connected
9	400cm	Connected
10	500cm	Not connected

Test results connectivity Bluetooth show that the HC-05 module is capable of connected with *smartphone* up to distance of 4m, and if exceed distance the so ability its connectivity will is lost so that officer must is at at least 4m from device breaker.

C. Disconnection delay testing electricity via smartphone

Testing sending command data sent officer to device breaker flow electricity use Android Bluetooth Controller application is done for know *delay* between time reception order with delivery.

Table 2. Testing Delivery Order Termination Electricity Flow from *Smartphone* Officer

Testing to -	Delivery Order Power Outage	Waiting Time (s)	Speed Response
1	Succeed	0.8	Fast
2	Succeed	0.7	Fast
3	Succeed	0.8	Fast
4	Succeed	0.6	Fast
5	Succeed	0.9	Fast
6	Succeed	1.0	Fast
7	Succeed	1.0	Fast
8	Succeed	0.9	Fast
9	Succeed	0.8	Fast
10	Succeed	0.8	Fast
Average delay		0.8	

Table 2 shows the average delay between orders given by officers with pressing *button* on the Android Bluetooth Controller application installed on *the smartphone* to device breaker flow electricity generated is 0.8 seconds which is classified as fast so that make it easier officer for decide flow electricity in a way *real-time*.

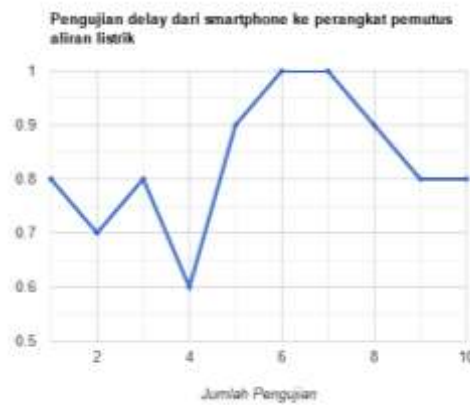


Figure 5. Graph Delivery Delay Testing

D. Testing android bluetooth controller app

Testing done on the Android Bluetooth Controller application that has been installed on *smartphone* officer. After officer activate bluetooth on *smartphone*, then application will in a way automatic look for device Bluetooth closest to *be* paired. Application Then will give choice function like control lamps and the like.



Figure 6. Display Blynk App

Appearance application contains a button widget with two conditions namely TURN ON which provides order termination flow electricity to the Arduino Uno and TURN OFF which disables order termination the.

CONCLUSION

Fundamental Finding : This study concludes that the innovation of developing an electricity flow breaker device utilizing Bluetooth technology connected to a smartphone successfully achieves its intended purpose of increasing efficiency and operational speed for officers handling PLN electricity customers who have completed their bill payments. The prototype device functions effectively in accordance with the initial research objectives, demonstrating reliable performance and practical applicability in real field operations. **Implication :** The successful implementation of this Bluetooth-based system signifies the potential for broader adoption of smart technology in utility service management, contributing to faster response times, reduced manual workload, and enhanced customer service quality. **Limitation :** However, the study's testing phase remains limited in scale, focusing primarily on functional performance without extensive field trials under varying environmental and operational conditions. **Future Research :** Further research should expand the device's testing to larger-scale environments, integrate Internet of Things (IoT) capabilities for remote monitoring, and assess long-term durability and energy efficiency. This will help refine the system and ensure its sustainable integration into digital utility management frameworks.

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