

Implementation of Smart Receptacle Based on The Internet of Things as Improving The Quality of Micro, Small and Medium Enterprises

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Article Information	ABSTRACT
Article History Received : November 04, 2024 Revised : November 30, 2024 Published : January 02, 2025	The phenomenon of "chargers" is where visitors come to a cafe just to charge their smartphones or laptops without ordering food or drinks. This condition is becoming more prevalent due to various variables, including the rising utilization of smartphones and laptops, the necessity to charge devices while traveling, and cafés becoming the primary charging option due to their complimentary Wi-Fi and a conducive environment. The Smart Receptacle is a power outlet utilizing an ESP8266 microprocessor, capable of monitoring electric current and calculating use fees depending on a predefined program. This product utilizes the Internet of Things (IoT) to facilitate real-time monitoring of electric current via electronic devices. Smart Receptacle provides a solution for MSMEs, primarily targeting the Food & Beverage sector, while it is equally applicable to other industries necessitating efficiency and control in electricity consumption. This instrument can quantify the power utilized and compute the electricity consumption of each electrical gadget employed.
Keywords: <i>Internet of Things; ESP8266; PZEM004T; Blynk</i>	

INTRODUCTION

The lack of energy is a problem that impacts economies, cultures, and the environment globally, especially in Indonesia (L. Pagaduan et al., 2023). Figure 1 presents data on the problems encountered by MSMEs, including adopting digital technology, which stands at 30.9% (Aini et al., 2024)

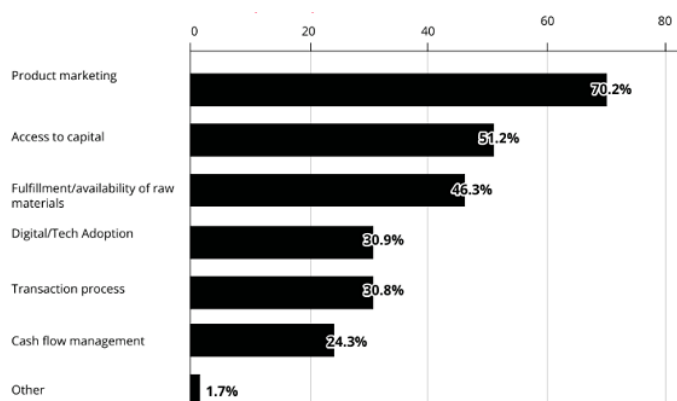


Figure 1. MSME Empowerment Report 2022

Indonesia can enhance its economy by capitalizing on the Industrial Revolution (Aziz, 2019). The technological advancements of the Fourth Industrial Revolution present an opportunity for Micro, Small, and Medium Enterprises (MSMEs) to progress through many innovations. Digital innovation is accelerating the potential and expansion of MSMEs for sustainable economic growth and inclusive entrepreneurship, changing these enterprises in both urban and rural areas (Mahesh K. et al., 2023).

Electricity is a fundamental necessity for every individual in the contemporary society. Electricity is essential for all domestic appliances, transportation systems, refrigeration, illumination, and heating (Gopal et al., 2020a; Naik & Sudarshan, 2019). Several variables can impact the dependability and efficiency of solar power systems. In response to these issues, technologies have been created to measure and optimize solar power system performance ("SOLAR POWER MONITORING SYSTEM USING IOT," 2023). Every management system aims to provide remote, portable, and automated control. The innovative smart energy meter presented in this work is part of an advanced and automated metering and billing system. Certain predetermined automatic operations are provided to the meter reading system through the combination of the Arduino and GSM Short Message Service (SMS) (Rahman et al., 2015). Recently, smart energy management systems have proved successful methods to maximize energy output, predict demand response, optimize energy usage, and conduct grid self-diagnosis. Utilizing real-time key performance indicators associated with energy, these systems offer insights into energy dynamics within the electrical power grid, allowing producers and consumers to make decisions that enhance their energy efficiency (Laayati et al., 2022). The condition of smart electrical appliances in residences and structures is assessed through numerous research initiatives on IoT energy monitoring. They promptly report energy use and display the equipment's current condition (Chaiyong & Sonasang, 2022).

According to prior research, the Internet of Things is a vital contemporary technology that enhances convenience and intelligence in daily life (Gopal et al., 2020b). Integrating the Internet of Things (IoT) in micro, small, and medium enterprises (MSMEs) presents the potential to enhance operational efficiency, save expenses, and create new revenue. This research demonstrates that IoT offers a solution for MSMEs to optimize electrical energy use, hence enhancing efficiency and reducing operational expenses. This is achieved by implementing intelligent receptacles in cafes inside MSMEs by utilizing sensors and smart gadgets that monitor and regulate electrical energy consumption. This instrument can ascertain the quantity of electrical power consumption.

Alterations in individuals' lifestyles, including completing assignments, attending meetings, or just relaxing at a café, involve prolonged engagement in activities that necessitate the use of electronic devices such as smartphones and laptops, which require recharging. Typically, patrons order merely a cup of coffee yet occupy the café for extended periods while charging their laptops and smartphones or utilizing other technological gadgets. The deployment of IoT involves the research of a mirrored display KWH meter to monitor electricity use utilizing the ESP 32-CAM microcontroller (Christanto et al., 2022). This research employs IoT in smart receptacle devices capable of measuring electricity consumption when applied in MSMEs. By monitoring usage in real-time, MSMEs may pinpoint gadgets that consume the most electricity and differentiate between the electrical costs incurred by consumers and the expenses associated with food or beverages ordered.

Implementing a smart receptacle may provide a way for MSMEs to address this issue. Consumers' electrical power consumption for their electronic gadgets can be monitored and invoiced accordingly. These costs are not solely attributed to client orders. Conversely, intelligent outlets can regulate electrical energy use for MSME operators. They can ascertain the daily consumption of electrical energy.

LITERATURE REVIEW

Industrial Revolution 4.0

The Industrial Revolution 4.0 represents a convergence of automation technology and digital technology. This is marked by enhanced connectivity, interaction, and increasingly convergent relationships among humans, machines, and other resources via information and communication technology (Avotins et al., 2018). The Industry 4.0 revolution possesses the capacity to profoundly transform business and industrial operations, generating new opportunities and challenging established paradigms. In this situation, business entities must adapt and investigate the possibilities of emerging technologies to enhance competitiveness and innovation. The integration of supplementary sensor types into the system enables IoT solutions to enhance process and business monitoring and management capabilities. They facilitate the collection of more accurate consumption data (Hidayat, 2023; Mazur, 2022).

Internet of Things

During this period, the internet underwent swift evolution, transitioning from computer machines and software services to encompass a diverse array of devices, including sensors, actuators, robotics, electronic devices, and automobiles (Liberg et al., 2020). The Internet of Things (IoT) refers to a paradigm in which devices are capable of connecting and communicating with one another through the internet ("INTERNET OF THINGS-IOT," 2019). The Internet of Things (IoT) is a strategic concept with extensive implications, underpinned by advanced information and communication technology infrastructure.

The utilization of smart devices and the Internet within the Internet of Things (IoT) offers novel solutions to diverse challenges and issues pertinent to business, government, and industry globally (Bradú et al., 2022; Sisinni et al., 2018). It can be stated that the Internet of Things (IoT) is an invention that integrates frameworks, devices, intelligent systems, and smart sensors. Data gathered by IoT devices can facilitate analysis, monitoring, and enhanced decision-making. Instances of IoT applications encompass sensors integrated into domestic appliances like refrigerators and ovens, vehicles outfitted with engine condition monitoring sensors, and urban infrastructure enhanced with air quality monitoring sensors. The deployment of IoT has the potential to enhance efficiency, productivity, and comfort across multiple domains. This advancement necessitates enhancements in data security, privacy, and interoperability.

Microcontroller ESP8266

NodeMCU, an open-source IoT platform, is seen in Figure 2. This hardware comprises the ESP8266-12 System On Chip (SoC) manufactured by Espressif Systems and utilizes firmware that employs the Lua scripting programming language (Baicu et al., 2023; Litayem & Al-Sa'di, 2023). This microcontroller is explicitly engineered for IoT applications necessitating wireless connectivity. The ESP8266 is capable of connecting to a Wi-Fi network, enabling the device to interact with the internet or a local network (Anderies et al., 2023). The ESP8266's cost-effectiveness, integrated Wi-Fi, and ease of usage facilitated its surge in popularity. IoT application development, instruction, and prototyping extensively utilize it.

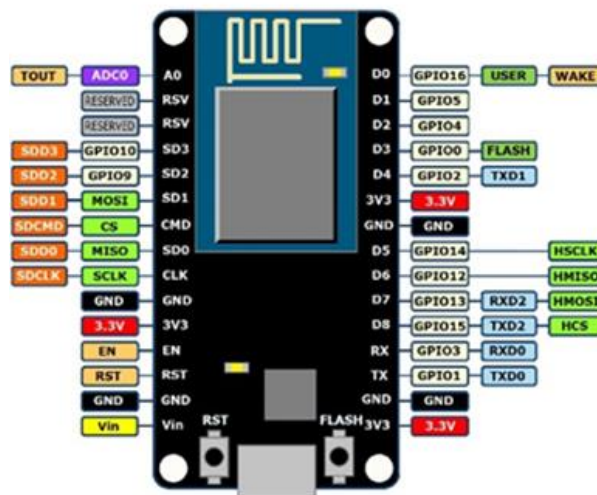


Figure 2. NodeMCU ESP8266 V3

PZEM004T

The PZEM-004T is a digital power monitoring module capable of measuring and reporting various electrical parameters in an AC power system. The sensor depicted in Figure 3 operates as an input device that quantifies voltage, current, active power, and power consumption inside the system (Adkhar & Afianti, 2023; Tobi & Van Harling, 2021). The primary function of the PZEM-004T is to deliver comprehensive, precise, and real-time electrical measurements for diverse power-related applications, such as energy monitoring, load balancing, power quality analysis, integration into home/building automation systems, industrial equipment monitoring, and renewable energy initiatives. The device employs serial communication for sensor data, utilizing the RX (Receive) pin for data reception and the TX (Transmit) pin for data transmission (Reshma et al., 2024). The PZEM004T possesses the capability to measure power up to several kilowatts, features a serial communication port, and can connect with various microcontrollers.

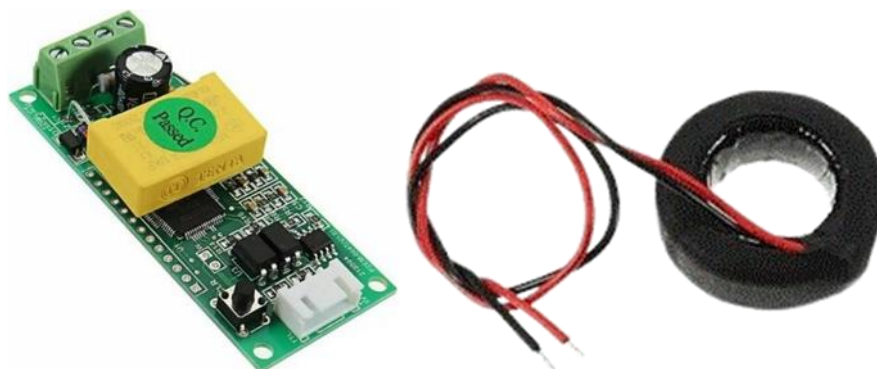


Figure 3. PZEM004T Sensor

Blynk

Blynk is a platform designed to manage hardware devices, including ESP8266, Arduino, and various modules, via iOS and Android applications. Blynk was developed to facilitate remote hardware control, show sensor information, and save data. (Abdulahakeem Hailan et al., 2023). Blynk enables users to develop applications for smart devices without requiring extensive programming expertise. Blynk's major objective is to facilitate the creation, maintenance, and interaction with Internet of Things applications by providing a comprehensive platform for

hardware-software integration, mobile app development, data visualization, and remote access (Jaber et al., 2019).

RESEARCH METHOD

This research initiates the design of the system, hardware, and software to develop a system that meets specified requirements. At the last step of the research, data will be collected every 10 minutes under varying loads to evaluate the functionality of the created smart receptacle tool. Figure 4 below is a block schematic of the designed smart receptacle. The PZEM004T sensor measures current, voltage, and power, after which the ESP8266 microcontroller processes the data for display on the Blynk server. Current and voltage regulation is executed by a relay module, with control process data supplied via the ESP8266 to Blynk, which is operable through a smartphone.

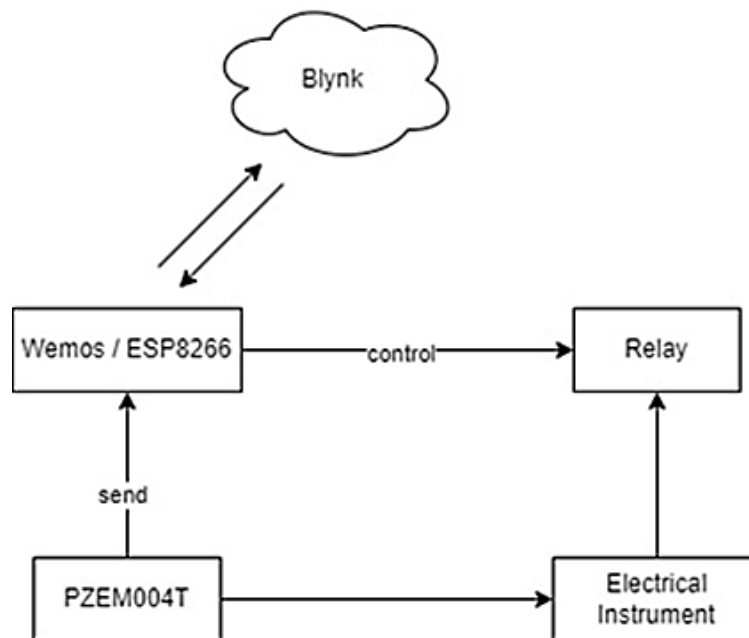


Figure 4. Block Diagram of Smart Receptacle

Figure 5 below illustrates a research flow diagram detailing the phases involved in adopting a smart receptacle system to ascertain the power costs incurred by electric power users, as well as to regulate current and voltage.

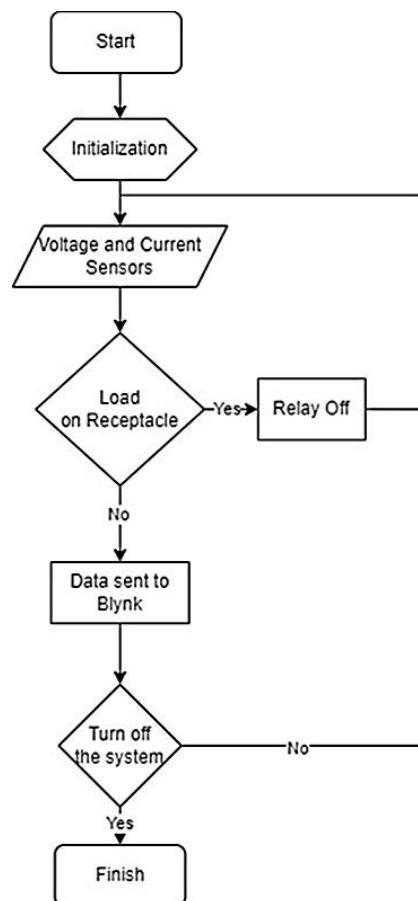


Figure 5. Flow Chart for Smart Receptacle Research

The smart receptacle device incorporates electronic components as depicted in Figure 6, comprising the ESP8266 microcontroller, PZEM004T sensor, 2-channel relay module, HLK5M05, and current transformer.

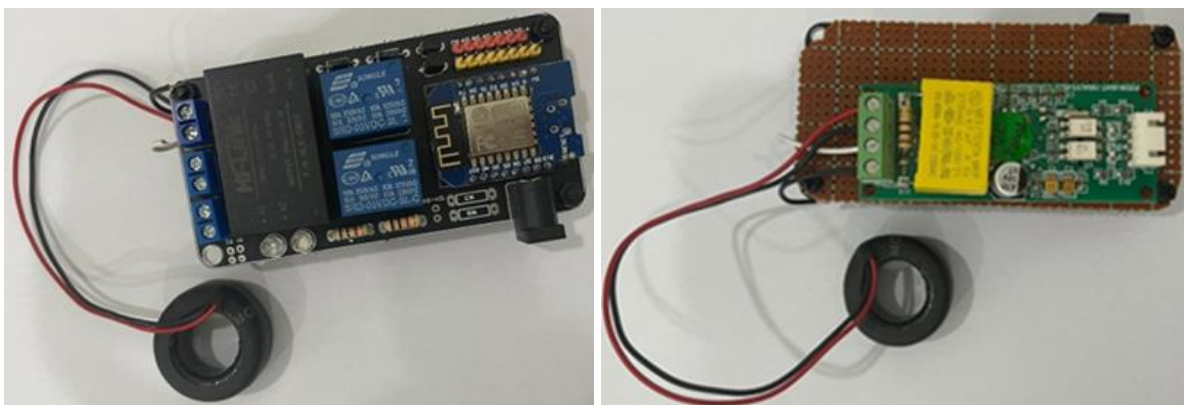


Figure 6. Design of a Smart Receptacle Device

RESULT AND DISCUSSION

This research involved testing two types of electrical devices frequently utilized by consumers in coffee shops: cellular phones and laptops. Presented in Tables 1, 2, and 3 below.

Table 1. Test Results of Smart Receptacles for Laptop Load Categories

Time (minute)	V	I	P	Cost (Rp)
5	218,8	0,27	26,9	26,18
10	220,5	0,17	15,4	47,47
15	220,1	0,17	15	68,06

Table 2. Test Results of Smart Receptacles for Smartphone Load Categories

Time (minute)	V	I	P	Cost (Rp)
5	218,2	0,08	8,5	11,04
10	216,3	0,07	8,0	21,81
15	217,7	0,06	6,4	31,84

Table 3. Test Results for Smart Receptacles with Smartphone and Laptop Load Types

Time (menit)	V	I	P	Cost (Rp)
5	218,1	0,35	38,5	64,86
10	218,9	0,29	31,2	106,79
15	218,8	0,25	25,8	145,49

The table above displays the test results for two types of devices used as loads. The smart receptacle tool has successfully detected current, voltage, power, and electrical energy rates at 15-minute intervals, as indicated by the test results. Figure 6 below illustrates the Blynk interface for the tested smart receptacle device.

**Figure 7.** The interface of the Smart Receptacle Application on Blynk

Smart receptacles based on the Internet of Things (IoT) can enhance operational efficiency, productivity, and cost management in Micro, Small, and Medium Enterprises (MSMEs) by facilitating real-time monitoring of energy use, enabling owners to pinpoint energy-intensive devices and optimize their utilization. Remote control functionalities enable users to activate or deactivate devices from a distance, hence minimizing energy use. Furthermore, electrical cost analysis offers essential information for budget formulation, while the capacity to schedule devices enhances productivity. By monitoring current and voltage, these power outlets help prevent gadget damage, hence decreasing repair expenses. Moreover, the advocated energy-saving techniques strengthen sustainability, hence enhancing the firm reputation.

CONCLUSION

The smart receptacle is constructed utilizing a PZME004T sensor, an ESP8266 microprocessor, and a relay. Subsequently, testing was conducted with loads including computers and cellular phones, which were charged through a smart receptor. The test findings indicate that the smart receptacle prototype has successfully measured the values of current, voltage, power, and the cost of electrical energy consumed during load charging.

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