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Smart Warehouse Design With GAS Leak Detector and IoT Based Security System

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ABSTRACT

Security is one of the most important aspects of a system or environment, such as homes, offices, campuses, villages, cities, shopping centers, gas warehouses and other locations. LPG gas is a basic need that is distributed to the people of Indonesia through LPG gas bases or warehouses. It is possible for LPG gas cylinders to leak where detecting the occurrence of LPG gas leaks is quite difficult and even more so when the base is in a condition where no one is around, there is a high probability of explosion and fire incidents. The design of Smart Warehouse with a gas leak detector and security system based on the Internet of Things (IoT) aims to improve the security and efficiency of warehouse operations. In this research, the developed system utilizes the MQ-2 sensor for gas leak detection and the RC522 RFID module for access control and security monitoring. The results show that the MQ-2 sensor is able to detect gas leaks and send data to the microcontroller in real-time and provide early warning if a gas leak is detected. Meanwhile, the RC522 RFID is used for warehouse owner identification and authentication, preventing unauthorized access and managing inventory more effectively. The integration of these two technologies in the IoT platform enables remote monitoring and control of the warehouse through the Blynk app, which improves responsiveness to potential hazards and strengthens warehouse security. The system is expected to provide an effective solution to mitigate security risks and improve overall warehouse management.

Keyword : Internet of Things; LPG Gas; Smart Warehouse.

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1. INTRODUCTION

In the era of Industry 4.0, the integration of smart technologies has become essential for enhancing operational efficiency and safety standards across various sectors. Warehousing, as a vital component of supply chain and logistics, is undergoing rapid transformation through the adoption of automation and Internet of Things (IoT) technologies. Traditional warehouses, which often rely on manual processes and lack real-time monitoring capabilities, are increasingly being replaced or upgraded into smart warehouses that offer enhanced control, security, and responsiveness.

A significant risk in industrial and storage facilities is the potential for gas leaks, which can lead to catastrophic incidents if not detected promptly. The integration of a real-time gas leak detection system into a warehouse's infrastructure not only mitigates safety risks but also ensures compliance with occupational and environmental safety standards. Combined with an IoT-based security system, such a design enables continuous monitoring, automated alerts, and remote management, thereby increasing situational awareness and reducing human error.

This research proposes a smart warehouse design that incorporates a gas leak detector and a comprehensive IoT-based security system. The objective is to develop a prototype that demonstrates how sensor networks, cloud connectivity, and automated response mechanisms can work together to create a safer and more efficient storage environment. By leveraging low-cost, scalable technologies, this system aims to contribute to the modernization of warehouse management in both industrial and commercial settings.

With the development of technology that continues to increase, humans always want to use tools or technologies that can help their work, so that technology becomes a necessity for humans. The Internet of Things is a technology that allows devices and other systems to connect and exchange data

via the internet which can help change problems that use conventional systems to automatic systems (Effendi et al., 2022).

For now, the security of industrial spaces and locations such as warehouses must be discussed. Room security is also needed because of the high crime rate and worker mobility. There are several ways to make a room safer, one of which is to install a security lock on the door. However, that is not enough to prevent potential crimes (Putri et al., 2019).

To overcome this problem, the author will create a "Smart Warehouse Design with Gas Leak Detector and IoT-Based Security System". This can minimize the possibility of an explosion and provide convenience for LPG gas depot warehouse owners to access LPG gas depot warehouses. This study will use the MQ-2 sensor as a sensor to detect LPG gas concentration and RFID RC522 as an authentication sensor system that uses an ID Card in the form of an E-KTP and the Blynk application as a notification.

2. RESEARCH METHOD/MATERIAL AND METHOD/LETERATURE REVIEW

A. Research Stage

This research stage consists of the preparation stage, system requirements analysis, hardware design, software design, tool testing, and conclusion. The following are the overall research stages that can be seen in the following image:

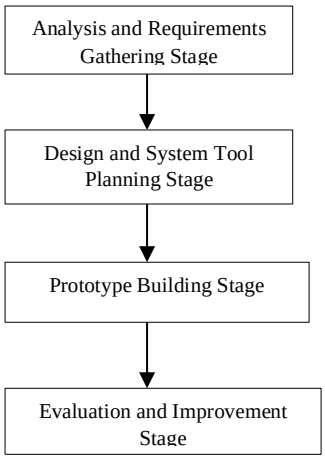

Fig 1. Research Stage

The explanation of the stages and research flow carried out are as follows:

1. Analysis and Needs Collection Stage
   At this stage, data collection is carried out through research and continued with observations made in everyday life in the surrounding environment by analyzing problems that arise related to the LPG gas depot warehouse.
2. Design and System Tool Design Stage
   At this stage, ideas and system and tool designs will be distributed in implementing the Internet of Things system into a Smart Warehouse Prototype using the Wemos D1 Mini ESP8266 microcontroller. The design focuses on the description of all aspects of the software from the user's perspective. At this stage, aspects include the output format, input and processes that will be created. The prototype design will be reviewed by the user and in the analysis section, the system design uses adjustments to the software requirements and tool systems that will be developed.
3. Prototype Building Stage
   In making the Prototype, it will be designed to adjust to user needs, so that at that time the researcher will know in more detail and what parts will be worked on. At this stage, it will also be implemented into an Internet of Things system on the Prototype Smart Warehouse using Arduino IDE. At this stage, a series of Smart Warehouse prototypes will be created containing several devices, namely the Wemos D1 Mini ESP8266 microcontroller, MQ-2 Sensor, RC522 RFID Sensor, DC Fan, Solenoid Door Lock, Buzzer, and LED. At this stage, a controller will also be built that can be controlled remotely by utilizing the Blynk application.

4. Evaluation and Improvement
   Stage At this stage, the system that has been created and is running will be implemented, so a mentoring method and also a review of the new or long-developed system are formed. Developers can also make comparisons between the two. The evaluation process will continue to be carried out on the system technically and operationally, as well as user interaction.

B. Overall Tool Design

The overall tool design is a circuit consisting of several components to form a unified system that has an input circuit, a process circuit and an output circuit. Wemos D1 Mini ESP8266 is the main component of this circuit. Data from all components will be processed in this microcontroller and produce an output that will display notifications on the Blynk application. The following is a description of the overall system circuit.

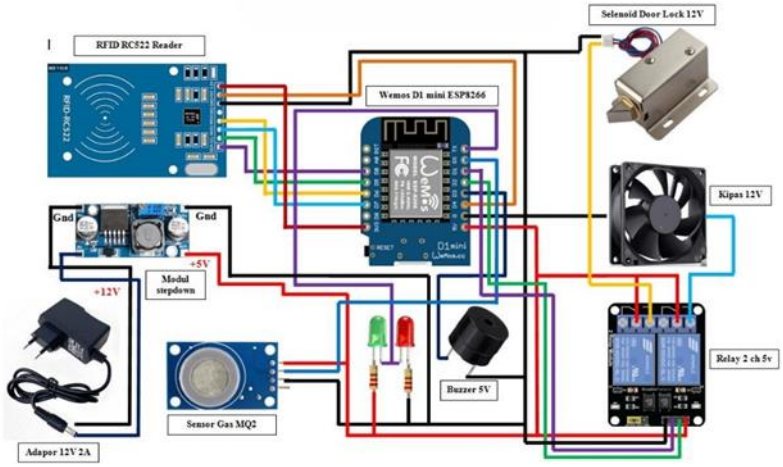

Fig 2. Overall Tool Design

3. RESULTS AND DISCUSSION

Based on the results of the analysis and design that have been carried out in the previous chapter, the design of a Smart Warehouse using MQ-2 sensors and RFID sensors has been made. So that in order to find out how the device functions, testing is carried out based on various conditions for the MQ-2 sensor and RFID sensor. In addition, testing has also been carried out to find out how the conditions of the system and this tool can be used optimally and appropriately. Testing will be carried out in several stages on the sensors contained in this system, namely:

1. Testing on the MQ-2 sensor
2. Testing on the RFID sensor
3. Testing on the Blynk application
4. Testing on the Blynk application notification

A. MQ-2 Sensor Testing

MQ-2 sensor testing is used to determine the level of responsiveness of the MQ-2 sensor to gas leaks. Testing is done using a gas lighter. The MQ-2 sensor will detect any gas leaks entering the sensor. Testing the MQ-2 sensor will be done by lighting a gas lighter and then directly facing the front of the MQ-2 sensor to determine whether the MQ-2 sensor can detect gas leaks.

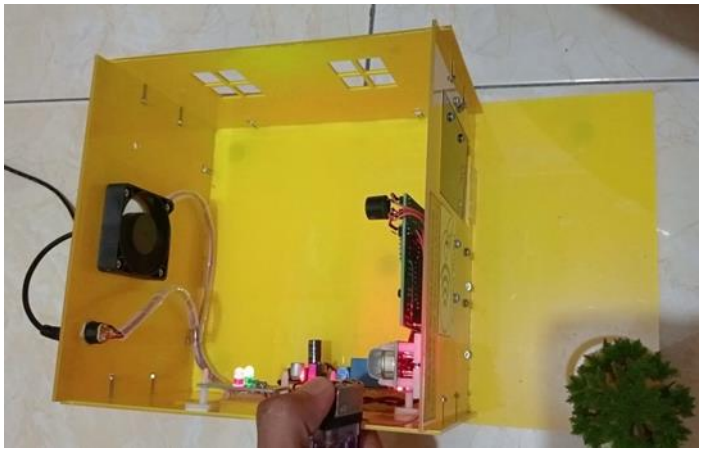

Fig 3. MQ-2 Sensor Testing

If the MQ-2 sensor detects a gas leak, the WEMOS D1 Mini ESP8266 will provide an output to the LED which will make the red LED active together with the green LED will be active and light up alternately, the buzzer will make a sound as a notification that a gas leak is detected produced from an intermediary in the form of a gas lighter, then the DC fan will turn on to filter out the leaking gas. However, if the MQ-2 sensor does not detect a gas leak, then only the green LED lights up indicating that no gas leak is detected.

B. RFID Sensor Testing

RFID sensor testing is used to determine the level of responsiveness of the RFID Reader sensor in scanning E-KTP so that only users who have previously registered E-KTP can access the warehouse door easily. Testing is carried out by using E-KTP as an ID Card by bringing the E-KTP as an ID Card close to the RFID Reader sensor so that the RFID Reader sensor can scan the previously registered E-KTP.

Fig 4. RFID Sensor Testing

If the RFID Reader sensor scans a previously registered E-KTP, the WEMOS D1 Mini ESP8266 will provide an output to the solenoid door lock which will make the locking lever enter the solenoid door lock and the buzzer will sound as a notification that the warehouse door has been opened because it was accessed using an E-KTP as an ID Card that was previously registered. However, if the RFID Reader sensor scans an E-KTP that was not previously registered, the solenoid door lock lever will remain in the locked position and the buzzer will sound as a notification that the warehouse door has been accessed using another ID Card that was not previously registered.

C. Blynk Application Testing

Blynk application testing is used to determine the appearance of the user interface on the Blynk application so that it can function properly so that users can monitor detected gas leaks and can easily access the warehouse door besides using E-KTP as an ID Card.

Fig 5. Blynk App View

In Figure 5, there is a display, namely the option switch button in the form of (ON/OFF). When the option switch button is pressed to ON, the user does not need to use the E-KTP as an ID Card to access the warehouse door, but only needs to press and hold the OPEN button so that the warehouse door can be opened automatically. This option switch button can be an alternative for users if they forget to bring their E-KTP as an ID Card, so they can directly access the warehouse door by simply activating the option switch button to ON and pressing and holding the OPEN button available in the Blynk application using the user's smartphone. However, if the option switch button is pressed to OFF, the mechanism for opening the previous warehouse door which only uses the Blynk application will return to the previous one, namely using the previously registered E-KTP as an ID Card.

4. CONCLUSION

Based on the research and discussion that has been described, it can be concluded as follows: Overall, it can be said that this tool can function well as an early warning through the Blynk application if a gas leak occurs and provides easy access for users and additional security so that other people who do not have access cannot access the gas warehouse door. The application of the MQ-2 sensor and RFID sensor for gas leak detection and internet of things (IoT)-based security is running well and as expected. This is evidenced by real-time system testing and can be controlled and monitored remotely, the MQ-2 sensor can be used to detect gas leaks, the RFID Reader sensor can be used to scan E-KTP registered as an ID Card, and the Blynk application can function when the MQ-2 sensor detects a gas leak and controls access to the gas warehouse door.

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