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SMART LOCKER BOX FOR STORING GOODS USING ESP 8266 AND SMART PHONE

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ABSTRACT

Storage of goods in public areas, such as in the Al Furqon Mosque, is often a problem due to the lack of adequate security systems due to the absence of guards. This raises the risk of losing goods, so an effective and efficient solution is needed. This study aims to design and implement an ESP 8266-based smart locker box that can be controlled via a smartphone to improve security and comfort in storing goods. The research method used is the waterfall system development model, which includes the stages of needs analysis, system design, code, testing, and maintenance. This system is designed using the ESP 8266 module as the main controller connected to a smartphone application via a Wi-Fi connection. The main features include automatic locking and opening of the locker and notification of locker status via the application. The results of the study show that the smart locker box functions well, with a fast and accurate control response via a smartphone. This system has succeeded in improving the security of goods in storage areas, especially in public places such as mosques, by reducing the risk of losing goods. The impact of this research is the creation of an innovative technological solution to overcome security problems in storage areas without guards, as well as increasing the sense of security and comfort for users.

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1. INTRODUCTION

The internet is now a primary need for all levels of society regardless of social status. Based on the survey results of the Indonesian Internet Service Providers Association (APJII), internet users in Indonesia reached 215.63 million people in the 2022-2023 period. This number increased by 2.67% or around 5.6 million people compared to the previous period which was 210.03 million users. The number of internet users is equivalent to 78.19% of the total population of Indonesia which is 275.77 million people (APJII, 2023).

Likewise, according to statistical data from the Central Statistics Agency, in 2022, 67.88 percent of the population in Indonesia had owned a mobile phone. This figure has increased compared to the conditions in 2021 which reached 65.87 percent. (BPS, 2023)This increase shows a positive trend in mobile phone ownership among the Indonesian people, which increasingly supports technological accessibility. In addition, the spread of mobile phones is also an indicator of the growth of digital connectivity in various regions, including remote areas. This is in line with

government and private efforts to expand the reach of telecommunications infrastructure throughout Indonesia.

The use of mobile phones and the internet can take up to 24 hours a day, meaning that almost all information needs or even some aspects of human life can be obtained through these two media. This influence shows that digital technology has become an inseparable part of everyday life (Wijaya, AF, & Persada, YI, 2024). Various activities such as studying, working, and entertainment now depend on internet access and mobile phones. In addition, the ease of getting information instantly has also changed the mindset and lifestyle of modern society.

This study aims to control the storage box via Smarth Phone by knowing the status of the box's contents and locking it via a code sent from the box to the smartphone. This system is expected to improve efficiency and security in the use of storage boxes. By using ESP 8266 and Smart Phone, users can access information about the storage box in real-time without having to be on site. The case study in this study is the storage box at the Alfurqon Mosque located on campus 1 UNSIQ Central Java in Wonosobo, which is expected to be a model for implementing similar technology elsewhere.

In some existing research, many control systems have been carried out, such as applications for controlling the opening and closing of house doors using infrared media. (Arduino, 2023). This kind of control concept has also been done using Bluetooth as an intermediary media to turn the lights on and off (Salim, 2016). Then there is also the concept an automatic water door control device with SIM800l based on Arduino Uno microcontroller which is done by using wireless connectivity as an intermediary medium (Dharma, I. P. L., Tansa, S., & Nasibu, I. Z., 2019).

In the context of use in public places such as schools or offices, smart lockers using ESP8266 can simplify administration in managing goods. Various advantages offered by smart locker boxes based on ESP8266, this technology has the potential to be a more efficient and secure solution in managing storage of goods in various public places. This research can contribute to the development of technology that continues to advance, this system can be expanded in use and continue to be developed to provide greater benefits to the community, especially in terms of convenience and security.

2. METHOD

The system development design used is a linear system development method, or in English it is often called Waterfall. Waterfall provides a systematic and sequential system development approach. This model develops systematically from one stage to another in a waterfall-like fashion (Wijaya, YD, & Astuti, MW, 2019). Waterfall has the advantage that the stages of the development process are fixed (certain), easy to apply, and the process is orderly (Murdiani, D., & Sobirin, M. 2022).

The stages in the waterfall are: system planning phase, analysis, design, code, testing and maintenance. (Dermawan, J., & Hartini, S).

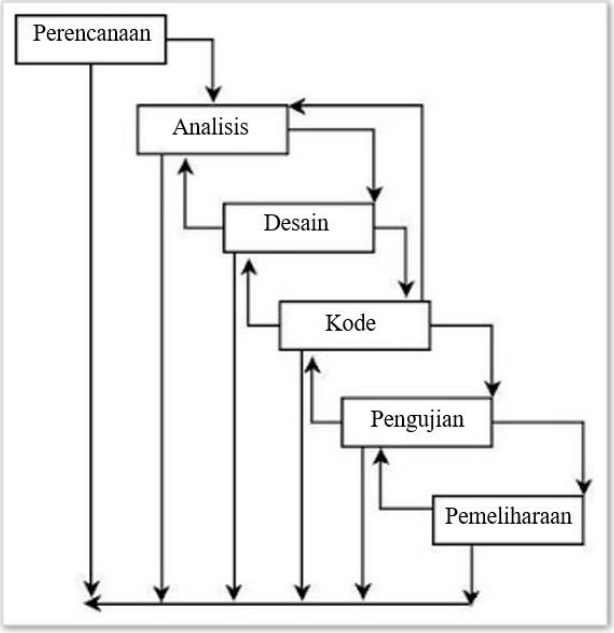

Figure 1Waterfall research design

a. Systems planning or engineering and modeling, including:
   1) System identification
      The system will be developed using a microcontroller often referred to as Arduino, this board uses Arduino ESP 8266 board manager which has a WiFi module installed in it. ESP32 has quite complete features because it supports Analog and Digital input or output, PWM, SPI, I2C, and others. Instructions in the form of scripts translated into C are written through the Arduino IDE (Integrated Development Environment) then uploaded to the microcontroller.

Figure 2Arduino IDE

Source: pinterest

Figure 3Arduino ESP 8266

Source: pinterest

Then, through the solenoid which is supplied with an electrical signal from the Arduino, a magnetic field will be generated inside the solenoid so that it will pull the lever in, and if the electric current is stopped, the lever will come back out (*default*).

Figure 4Solenoid

Source: pinterest

A large box measuring 40cm x 40cm as the main box for storing goods as well as a home for the series of system components to be built.

2) User needs study
   The user here is the person who will deposit their goods into the storage box. Without the need for the box to be guarded, the person who will deposit just needs to log in to the wifi box and then can find out the status of the contents of the box or not and the user will be sent a Key Code or key code from this Smart Locker System which later the code can be used to open the box again.
3) Feasibility study of the system both technically and technologically
4) System development scheduling

b. Software requirements analysis.
   In this phase, the collection of requirements is intensified and focused on the system to be built, including:
   1) Identification of information domains
   2) System behavior
   3) Work method
   4) System interface.

5) The requirements for the system are documented and consulted again with the users.

c. Design

This phase focuses on the design process of data structures, system architecture, interface representation and program algorithms.

d. Code

After the design process is complete, the results must be translated into a computer program which then produces a system.

e. Testing

Testing is done to find errors that may occur in the coding process and to ensure that the limited input produces results that meet requirements.

f. Maintenance

At this stage , the system that has been built then maintained or maintained. This process is carried out after the system created is given to the user, especially if the system has problems that have not been found during the testing process. These problems can come from user requests that require system repair or adjustment to the external environment, such as changes and additions of features or changes to the operating system. After the maintenance phase, the developer must repeat each stage of system development from the beginning, but without creating a new system .

3. RESULTS AND DISCUSSION

a. Research result

The results of the study show that the storage box designed to be able to open and lock automatically based on a predetermined scenario is in accordance with expectations. This automation mechanism shows that the system works well in responding to commands or conditions that are set, so that it can increase user efficiency and convenience. The value entered via smartphone will be read by the Web Server on the ESP 8266 via wireless media and translated into a series of numbers as a key to open the storage box.

Figure 5smart locker for storing goods

1) Smarth locker box infrastructure for storing goods

Smart lockers are built by depicting the integration scheme between the components as shown in Figure 6 below:

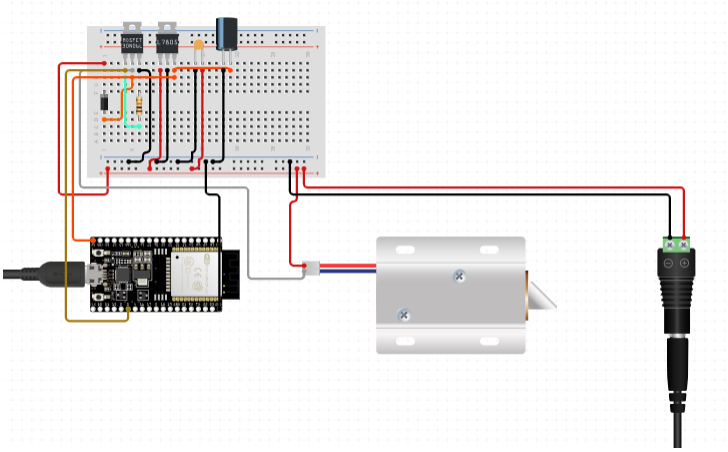

Figure 6Smart locker box storage system infrastructure

system is built with several main electronic components such as Arduino ESP 8266 as a server and solenoid as a tool to receive valve opening and closing commands.

Table 1List of components of the smart locker box storage system

No	Component Name	Function
1	Arduino ESP8266	As a Server
2	Solenoid	Lock
3	Breadboard	Component Board
4	Jack Power	Current distributor
5	Wiring	Connection between components

2) Smart Locker Codification

The process that runs on the smart locker system is a structured algorithm where each execution step is interrelated. The following is an example of a listing of the main display program for *the end user*.

```
<h1>AUTOMATIC STORAGE</h1>
<h2>AL-FURQON MOSQUE<br>
UNIVERSITY OF QUR'AN SCIENCE (UNSIQ) <br>
CENTRAL JAVA IN WONOSOBO </h2>
```

Continue with the connectivity steps to the server from the smartphone via the following code:

```
IPAddress local_ IP( 192, 168, 0, 101);
IPAddress gateway( 192, 168, 0, 1);
IPAddress subnet( 255, 255, 0, 0);
IPAddress primaryDNS( 8, 8, 8, 8);
IPAddress secondaryDNS( 8, 8, 4, 4);
WiFi.begin(ssid, password)
```

On the server side, the program code will read input from the user and generate random numbers for the user , but before that, the EEPROM memory is read first. If the EEPROM still contains a number other than 0, it means that the box is currently filled. Conversely, if the EEPROM is 0, it means that the box is ready to be filled.

```
int checkBox = EEPROM.read(0);
EEPROM.write(0,0);
checkBox = EEPROM.read(0)
```

3) **Operational** Steps

This stage explains the operational steps of this smart locker box for storing goods.

1. Connect Smartphone WIFI to Al-Furqon Automatika Storage ”
2. Open the browser (chrome) on your smartphone and type the address 192.168.0.101
3. Wait for the application page to open, Press the Submit button to open the box
4. Enter the items you want to save
5. Press a maximum of 4 digits to lock it, then the system will generate the number and it will be displayed, memorize the generated number to open the box.

b. Discussion

Through the existing infrastructure and components, it provides research results that are in accordance with expectations, the suitability of these results can be measured by testing the system's functionality using blackbox testing and testing the benefits using usability testing (Pramudita 2020)

1) Black box testing

Table 2Black Box Testing

No	Function	Mark	Results
1	Connection	In accordance	WIFI Connected
2	Connection	It is not in accordance with	WIFI Not Connected
3	Check Box	Containing	Box not Open
4	Check Box	Does not contain	Open Box
5	Key Input	In accordance	Open Box
6	Key Input	It is not in accordance with	Box does not open

2) Usability testing

Usability measurement is carried out by calculating the percentage of answers from respondents using the formula stated in the feasibility presentation (Sugiyono 2011)

$$\frac{skor\ yang\ di\ observasi}{skor\ yang\ diharapkan} x100$$

The data that has been collected is then converted according to eligibility categories, as shown in the following table

Table 3Eligibility categories (Azmi, Kamin, and Noordin 2003)

Numbers in Percentage	Eligibility
<21	Totally unworthy
21-40	Not feasible
41-60	Enough
61-80	Worthy
81-100	Very worthy

In this *usability* testing, the researcher only used the *Ease of Use aspect* of the three existing *usability aspects* (Lund 2001) . Data was taken from 10 respondents as application users by obtaining known values using the Likert scale (Nurul Anisaha 2024) . The average answer from this scale is 8.4 so the results are as follows:

$$= \frac{8{,}4}{10} x100$$
$$= 8{,}4\%$$

In accordance with the results of the analysis of the processed questionnaire data obtained, according to table 3, the feasibility category states that the smart locker box application for storing goods is declared very feasible.

4. CONCLUSION

Based on the design, implementation and testing results of the Smart Locker for storing goods , it can be concluded that the design is made of several components such as the Arduino ESP 8266 board manager as a container for instruction scripts, a 12 Volt Selenoid as a function to open and close the Box door, and the storage Box itself as a storage place. The Key Code or code key is generated by the system and sent via Wifi ESP 8266 to the user's Smartphone and the Box is locked, and with this code the user can open the Box again. Users via smartphones must access the IP address of the Wifi ESP 8266, this step is considered less practical because the combination of IP addresses is quite long, so it is necessary to develop a mobile-based application . The results of the study showed the success of the storage box system which was able to open and lock automatically according to the designed scenario. This system operates with precision, proving the reliability of the automation mechanism applied. As a result, this technology can increase user comfort, reduce the risk of manual errors, and speed up the storage process in various situations, such as in public places or facilities with high mobility.

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