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Hajj Participant Monitoring System Using GPS with Internet of Things (IoT) Based on Cloud Computing

Muhammad Rifky Saiful Qadr[1*], Ari Purno Wahyu Wibowo[2]
Universitas Widyatama Bandung, Indonesia
Email: saiful.qadr@widyatama.ac.id
*Correspondence

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ABSTRACT

This research focuses on the development and implementation of a web-based system that integrates GPS and Internet of Things (IoT) technology to monitor the real-time location of Hajj participants. The system leverages GPS to track participant locations accurately, enhancing safety and optimizing participant mobility management. IoT devices are integrated into the system to collect data related to participants' locations and conditions, which are then transmitted to a secure server for seamless access through the web platform. This research method uses a qualitative approach. The findings demonstrate that the integration of GPS and IoT with a cloud-based platform significantly enhances the management of Hajj participants, providing a robust and scalable solution for real-time monitoring, efficient coordination, and improved safety. The proposed system contributes to advancing technological solutions in large-scale religious gatherings, offering practical implications for future applications in similar contexts. The study concluded that real-time location monitoring using GPS allows hajj organizers to track participants' locations accurately and quickly, thereby improving their safety and mobility management. IoT device integration facilitates the collection of data about the location and condition of participants, transmitting this information to a server for web-based system access, which requires secure and stable configuration for continuous updates.

Introduction

The implementation of the hajj is one of the pillars of Islam that must be carried out by every Muslim who can afford it, and requires careful planning and supervision, considering the complexity and large number of participants. Every year, thousands of pilgrims from all over the world gather in the holy land, making it one of the most challenging logistical and managerial operations. (AL HAD, 2019)

In this context, supervision and monitoring of hajj participants is very important to ensure their safety, security, and comfort during the implementation of worship. However, conventional management often faces challenges related to information and

communication limitations, especially in dealing with problems such as loss of participants, delays, or emergencies (Kawasi et al., 2024).

With technological advancements, especially in the field of GPS and the Internet of Things (IoT), there is an opportunity to improve monitoring systems with more efficient technology-based solutions (Amane et al., 2023). GPS technology allows real-time tracking of attendees' locations, while IoT can connect various devices to facilitate integrated data collection and analysis (Binsawad & Albahar, 2022).

The monitoring system for hajj participants using GPS with a website-based Internet of Things (IoT) covers several important aspects such as the need for effective monitoring with a very large number of hajj participants, monitoring and managing them becomes a big challenge. Conventional systems are often inadequate in terms of accuracy and efficiency (Shambour & Gutub, 2022). GPS (Global Positioning System) technology provides real-time location data, which is very useful for tracking the movements of pilgrims and ensuring they are in the right place (Sawitri, 2023).

The Internet of Things (IoT) refers to a network of devices that are interconnected and can communicate over the Internet. In this context, IoT devices can transmit location data directly from pilgrims to a central server. Using the website as a platform allows for easy access from a variety of devices and locations. Authorities and officers can monitor and manage data in real time from a web-based system. (Sawitri, 2023).

This system can improve the safety and comfort of hajj participants, facilitate coordination in emergencies, and provide useful data for future analysis and planning (Haji et al., 2024). The use of the latest technologies such as GPS and IoT in hajj monitoring systems provides a more sophisticated and efficient solution than traditional methods, improving the safety and management of events.

Overall, the integration of GPS and IoT technology with a website-based platform is expected to improve the hajj experience by providing better control and monitoring. (Showail, 2022).

The use of this technology in the form of a cloud computing-based system offers an innovative and practical solution. With this system, hajj officers can monitor the location of participants directly through a platform connected to the internet, receive notifications in case of location shifts or other problems, and access the necessary data easily and quickly. (Dana, 1997).

Therefore, this final project aims to develop and analyze a monitoring system for hajj participants using website-based GPS and IoT technology. It is hoped that this system can make a positive contribution to improving the effectiveness of supervision and management of hajj participants, as well as ensuring a safer and more organized worship experience.

Based on the problems mentioned above, the author compiled a final project entitled "Monitoring System for Hajj Participants Using GPS with Internet of Things (IoT) Based on Cloud Computing".

The research on the problems that have been explained in the background of the problem, aims to develop and implement a system that utilizes GPS and IOT technology

to monitor the location of hajj participants in real-time through a website-based platform (Deshmukh & Kulkarni, 2009). Examine how to integrate IoT devices to collect data related to the location and condition of participants and send it to a website-based system effectively. Designing a website-based platform that provides an intuitive user interface to make it easier to manage, coordinate, and respond to hajj participants.

Method

Types and Data Sources

The design of the monitoring system for pilgrims using GPS with the Internet of Things (IoT) based on Cloud Computing uses a qualitative approach, which starts from the results of observations and interviews. The target of this cloud computing-based monitoring program is limited, so there can be a lot of data and there is no widening of the target.

The data sources needed in designing the monitoring system for hajj participants are described as follows:

1) Primary data, data obtained directly or during an interview.
2) Secondary data, data obtained indirectly or from journals or previous research to support writing.

Data Collection Techniques

To obtain the data needed for thesis report information, several data collection techniques are needed which are described as follows:

1) An interview is a conversation with a specific intention
2) Observation, is an activity carried out by researchers to collect data by the nature of the research because it conducts direct observations of the PT.Al Abadiyah Maju Bersama
3) A questionnaire is a data collection carried out by asking several questions to respondents who have directly used the Hajj participant monitoring program.

Needs Analysis

1) Input

An analysis of input needs is needed to explain what inputs are needed in the system later. The input data required is the login process, where users of this system are divided into 2 (two) access rights, namely admin and worshipper. The access rights and needs of each user are described as follows:

1. Admin

a) Have your username and password to log in to the system
b) Have access rights to view, add, edit, and delete the registration of Hajj and Umrah pilgrims who are not by the requirements
c) Have access rights to view, add, edit, and delete Badal Hajj and Umrah registrations that are not by the requirements
d) Have access rights to view, add, edit, and delete tourism rental registrations that are not by the requirements
e) Have access to edit FAQs

f) Have access to view the long and latitude coordinate points sent by the IOT tool
2. Pilgrims
a) Have your username and password to log in to the system
b) Have access rights to view, add, edit, and delete congregation profiles
c) Have access rights to check the Hajj or Umrah registration process
d) Have access rights to view the schedule of Hajj and Umrah manasic activities
e) Have access rights to view documentation of Hajj and Umrah activities

Output

Analysis of output needs is needed to find out what outputs are produced and displayed to system users. The output data that will be released by the system is described as follows:

1. Input and output of Hajj or Umrah registration
2. Report on the number of registrations of Hajj or Umrah pilgrims
3. Hajj Pilgrim Coordinate Point Report

Process

Analyze the needs of the process, and describe what processes will exist in the system. The processes that must exist in the system are described as follows:

1. The login and logou process, this process is needed so that not just anyone can access the system. Only people who have a username and password can access this system later.
2. The process of accessing each page, is a process where only users who have an account username and password can access every page in the system according to the access rights that have been given to each perpetrator.
3. The process of adding data, is a process that is carried out by adding data for each incoming item data to update the business processes carried out at PT. Alabadiyah Maju Bersama.
4. The data editing process is a process where users can change existing data without deleting the data itself.
5. The data deletion process is a process to make it easier for users to delete data that is no longer in use or delete data that has been input without having to open the database first.

Program Development Methods

After conducting observations and interviews with the owner of PT Alabadiyah Maju Bersama in Tangerang about what is expected in the location monitoring program, a mockup of the program was made. The design development process is adjusted to the needs of PT. Alabadiyah Maju Bersama, the use of coding for the stock monitoring program uses PHP and JavaScript programming languages.

Results and Discussion

Problem Identification

The Hajj Participant Monitoring System uses GPS with the Internet, of Things (IoT), a Website-Based to monitor the location of pilgrims while in the holy cities of

Makkah and Medina, as well as monitor the registration of prospective pilgrims along with the health conditions of pilgrims so that they are monitored in real-time and completely on the website (Ditha et al., 2023). Here's an analysis of the existing system:

1) Tracking the location of pilgrims in real-time
2) Tracking the registration of pilgrims in real time and clearly
3) Tracking the last health condition of pilgrims before leaving for the cities of Makkah and Medina
4) Knowing the location of lodging and activities while in the holy city of Makkah and Medina
5) Knowing TPHD, TPIH, TKHI officers, group leaders, group leaders, squad leaders, and pilgrims' roommates according to the location of the lodging

Analysis of Legacy Systems

Based on the results of observations and interviews conducted by the author with the chairman of PT. AlAbadiyah Maju Bersama, it can be concluded that in the registration service of Umrah pilgrims, they still use a manual process, namely filling out form data at the Office of PT. AlAbadiyah Maju Bersama Furthermore, check the administration of files such as ID cards, family cards, birth certificates, marriage certificates, passports, and registration funds of 25 – 30 million depending on the package chosen by the Umrah pilgrims. (Wagyana, 2019).

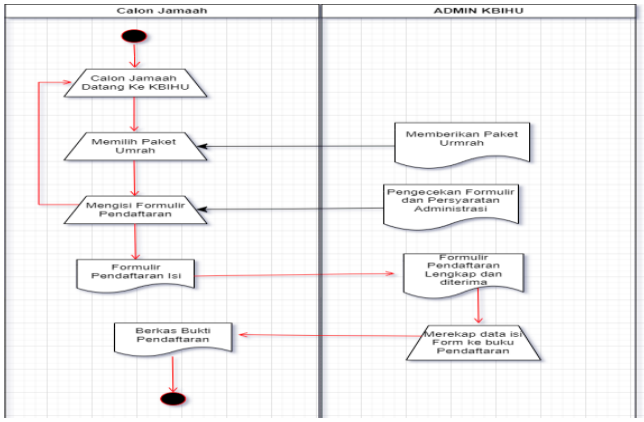

Figure 1
Umrah Registration Flowchart

Furthermore, the results of observations and interviews conducted by the author with the chairman of PT. AlAbadiyah Maju Bersama, it can be concluded that the search for Umrah and Hajj pilgrims still uses a manual process, namely conducting searches by attendance and rotating the Grand Mosque and the Prophet's Mosque. This causes several obstacles such as losing track with the guide and friends of the group.

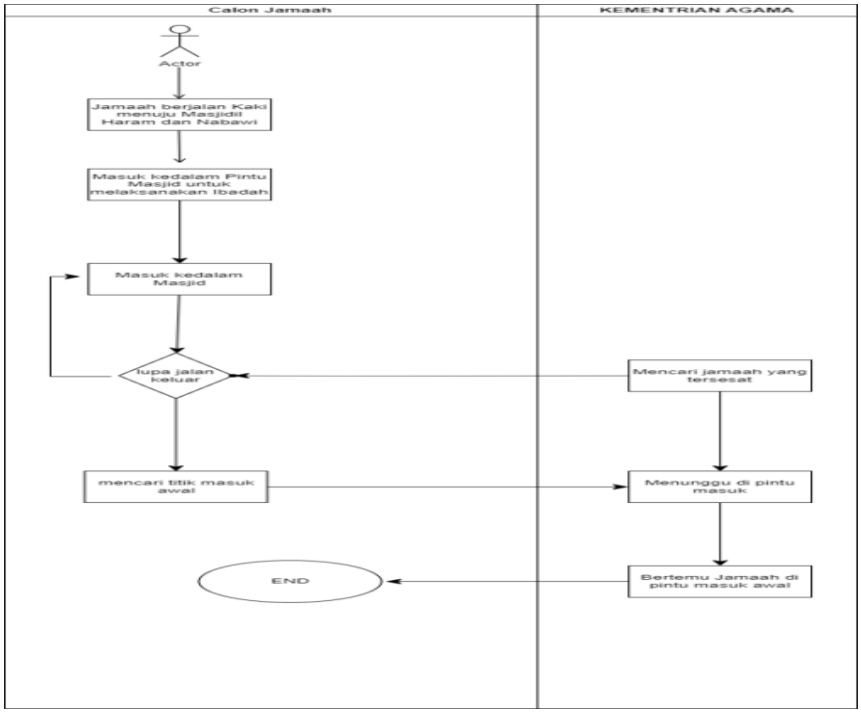

Figure 2 Flow map in people's search

1) Running System Evaluation

The system that is currently running at PT. Alabadiyah Maju Bersama Tangerang Regency when looking at the running procedures that are highlighted are the data collection procedures and the efficiency of pilgrims in registering and searching for lost pilgrims. (Iqbal, 2023).

In the process of carrying out activities, the registration process of pilgrims must go to travel, so that it is a consideration of the efficiency of time and energy carried out by pilgrims, especially for pilgrims who want to register for Umrah and Hajj at PT. Alabadiyah Maju Bersama However, the pilgrims are outside the city or have a residence far from the location of the Al Abadiyah office, the creation of forms that are still conventional in writing and then processed into the Microsoft Excel application results in the vulnerability of human error.

New System Analysis

From the above problems, a new system is needed, namely the Hajj Participant Monitoring System System Using GPS with Website-Based Internet of Things (IoT). Of course, it will also help prospective Umrah & Hajj pilgrims in their search for him when he is lost in the cities of Makkah and Medina. At the same time, it is important to understand the conditions of the registration position of Hajj participants, where each registration process is updated in real terms and the last hour is updated.

Figure 3
Flowmap of Hajj and Umrah Registration Proposal System

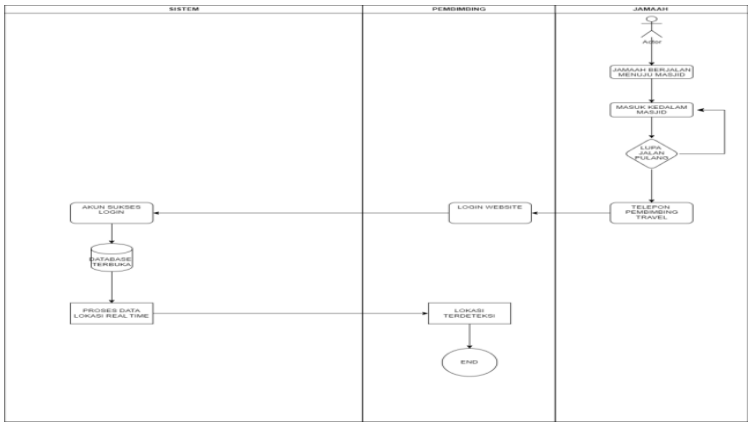

Figure 4
Flow map System Proposal

System Needs Analysis

The system built is accessed through a computer connected to the internet. To support access speed and perfect display. Requires other supporting devices to function as they should.

1) Hardware Requirements

Some of the hardware specifications used include:

a) Processor: Intel Pentium i 4.18 Gz
b) Ram: 8 GB
c) Hard Disk : 120 GB
d) Monitor: 15 inches 1920 x 1080
e) VGA Card: 512 Mb
f) Mouse
g) Keyboard

h) Nodemcu ESP8266
i) GPS Ublox Neo6M
2) Software Requirements
a) Operating System (Windows 8 / Windows 10)
b) Web Browser
c) Arduino Ide
d) XAMPP

System Design

In this study, a monitoring system will be designed in real-time using the Global Positioning System (GPS) module based on the Internet of Things (IoT). This device system is a monitoring system for monitoring the position of Hajj participants and information on Umrah packages as well as the number of Hajj and Umrah registrants, then the processed data is sent and stored in the database.

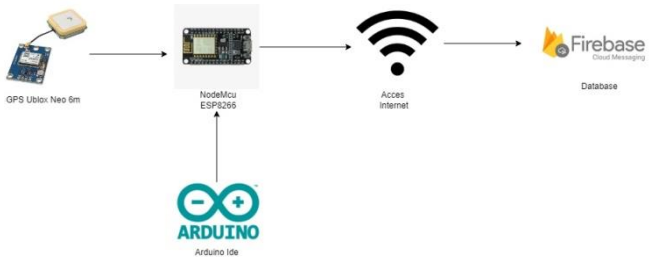

Figure 5. System Design

System Needs Analysis

1) UML process design
a. Use Case Diagram

In this use case diagram, it explains the interaction between the system and the actors (admins) involved with the system:

1. Definition of Actor

Table 1
Definition of Actor

It	Actor	Description
1.	Admin KBIHU	Managing pilgrim data and monitoring the location of pilgrims in Saudi Arabia

2. Definisi Use Case

Table 2
Definisi Use Case

It	Actor	Description
	Log in	Actors enter the system
	Input *pilgrim* data	Actors input, print, edit, and delete pilgrim data
	Monitoring the location of pilgrims	Actors monitor the location of pilgrims in real-time using the pilgrim data-id.
	Log out	Actor out of the system

3. Usecase Diagram Images

Figure 6
Diagram Usecase

4. Admin Login Usecase Scenario

Table 3
Admin Login Usecase Scenario

Use Case: Login			
Aktor : Admin KBIHU AL Abadiyah			
Description: Actor performs *Login* to use the system			
	Actor		System
1	Running the App		
		2	Displaying a login page
3	Fill out the login form.		
4	Pressing the login button		
		5	Data checking, if it fails, it will not be able to enter the main page, if successful, it will continue to the next page
		6	Displays the main page menu

5. Pilgrim Data Usecase Scenario

Table 4
Pilgrim Data Usecase Scenario

Use Case: Pilgrim Participant Data			
Aktor : Admin KBIHU AL Abadiyah			
Description: The actor enters pilgrim data			
	Actor		System
1	Running the App		
		2	Displaying the home page
3	Press the pilgrim data menu.		
		4	Displays the pilgrim data menu
5	Press the print button.		
		6	Displays a print view of the pilgrim data table
7	Press the add data button.		
		8	Displaying the display of the pilgrim registration form
9	Press the details button.		
		10	Displays the view of the pilgrims' details

11	Press the button to print the congregation's details.		
		12	Displays a printed view of pilgrim detail data
13	Press the edit button.		
		14	Displays the display of the edit form for pilgrims who have previously filled in data
15	Press the save button.		
		16	Saving edited data
17	Press the delete button.		
		18	Data in the table was successfully deleted.
		19	Pilgrim data displayed

6. Pilgrim Registration Scenario

Table 5
Pilgrim Data Usecase Scenario

Use Case: Umrah / Hajj / Transport Rental Registration			
Aktor : Admin KBIHU AL Abadiyah			
Description: The actor orders Umrah / Hajj / Transportation rental packages			
	Actor		System
1	Running the App		
		2	Displaying the home page
3	Press the message menu.		
		4	View the booking form page.
5	Press booking data		
		6	Sending order data to the server
7	Click upload requirements & proof of payment.		
		8	Displays the requirements met and proof of payment display
9	Press the print button.		
		10	Displaying the Hajah Requirements Form

7. Pilgrim Location Usecase Scenario

Table 6
Pilgrim Location Usecase Scenario

Use Case: Congregation Location			
Aktor : Admin KBIHU AL Abadiyah			
Description: The actor monitoring the location of pilgrims			
	Actor		Sistem
1	Running the App		
		2	Displaying the home page
3	Press the location menu.		

4	Press the pilgrim location menu.		
		5	Displays the data display of the pilgrim ID number, congregation name, action
6	Press search based on the pilgrim ID number		
		7	Displays the display of pilgrim data based on the pilgrim ID number
7	Press search by congregation name		
		8	Displays the display of pilgrim data by the name of the pilgrim
9	Press the action button.		
		10	Displays the location of pilgrims in real-time

8. Usecase Logout Scenario

Table 7
Usecase Logout Scenario

Use Case: *Logout*			
Aktor : Admin KBIHU AL Abadiyah			
Description: The actor logs *out* of the system			
Actor		System	
1	After the login process is successful;		
		2	Displaying the home page
3	Press the logout menu.		
		4	Log out of the system, displaying the login page.

9. Definition of Actor

Table 8
Definition of Actor

It	Actor	Description
1.	User	Entering *Personal Data*

10. Definisi Usecase

Table 9. Definition of Usecase

It	Actor	Description
1.	Doing activities on *the home web*	Actors do activities on the home page, such as reading package details, viewing package prices, and reading the Greetings of the Travel owner.
2.	Doing activities in *contact*	Actors do activities on the *Contact page*, such as viewing office

		addresses, email addresses, and cellphone numbers.
3.	Registering	The actor fills in personal data and prints proof of registration

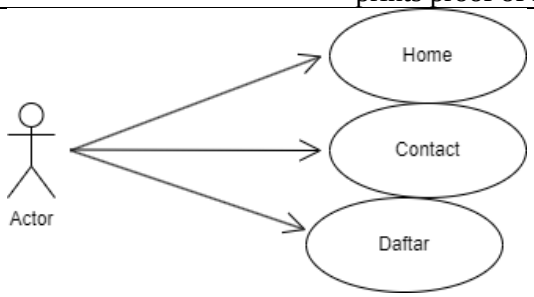

Figure 7. Definition of Usecase

Skenario Usecase Diagram User

Home Diagram Usecase Scenario Table

Table 10
User Diagram Usecase Scenario

Use Case: *Home*		
Actor: user		
Description: Actor performing activities in the home web		
	Actor	System
1	Go to the home page.	
	2	Displaying the home page
	3	The home page is displayed.

Table 11
Table Skenario Usecase Diagram Contact

Use Case: *Contact*		
Actor: user		
Description: Actor performs an activity on the *contact page*		
	Actor	System
1	Go to *the contact page.*	
	2	Displaying *the contact page*
	3	The contact page view is displayed.

Table 12
Scenario Table Usecase Diagram List

Use Case: Register		
Actor: user		
Description: Actor performing an activity on the list page		
	Actor	System
1	Go to the list page.	
	2	Displaying the registration page form
3.	Fill out the registration form.	

2	Press the register now button.	
		Storing data
		Data saved successfully
		Displaying a successful listing page
6.	Press the print proof of registration button.	
		Display a print view of the proof of list data.

Diagram Alur Data (Diagram Flow Data)

1) Context Diagram Context

Diagrams are the first stage in the data flow. A context diagram is the first overview of an application in general (top level) and is broken down into several parts. Context Diagram of the Hajj Participant Monitoring System Using GPS with Website-Based Internet of Things (IoT) in the image

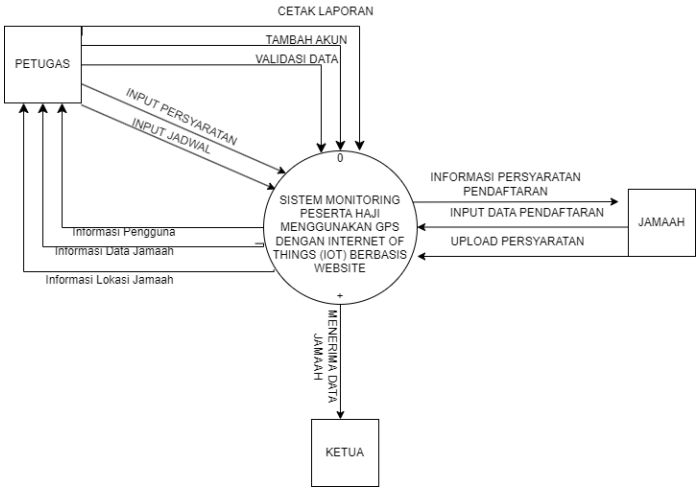

Figure 8
Context Diagram Image

2) Tiered Diagrams

A tiled diagram is a summary that maps the entire process going on in an application.

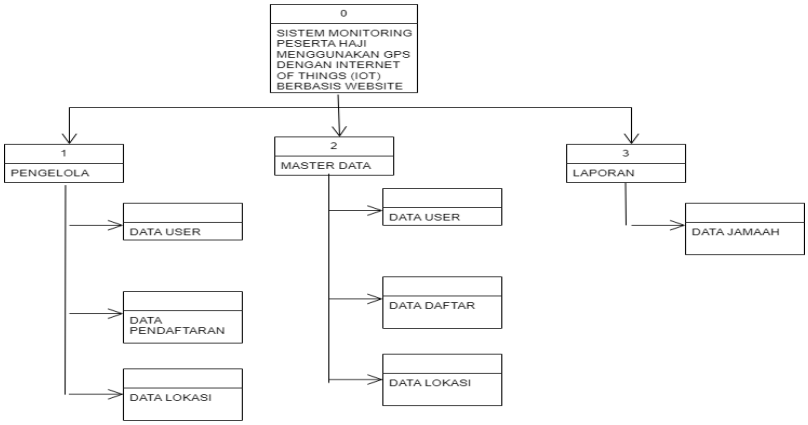

Figure 9
Tiered Diagrams

3) Data Flow Diagram Level 1

DFD is a development of Context Diagram. DFD breaks down the process from a Context Diagram into subprocesses which are then used to illustrate all processes in detail. From this description, levels will be formed. The figure shows the Data flow diagram for level 1 data processing.

a. Data Flow Diagram

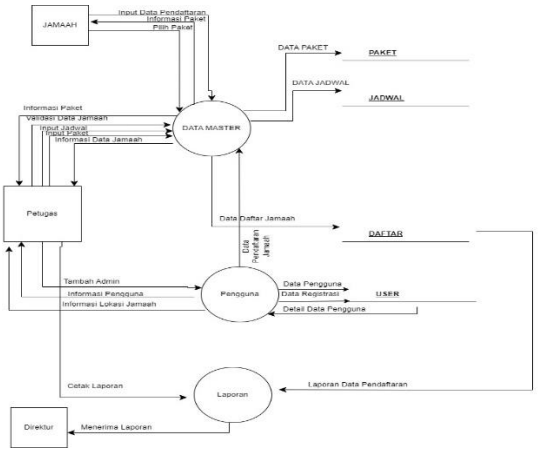

Figure 10. DFD Level 1

b. DFD Level 2 for location search

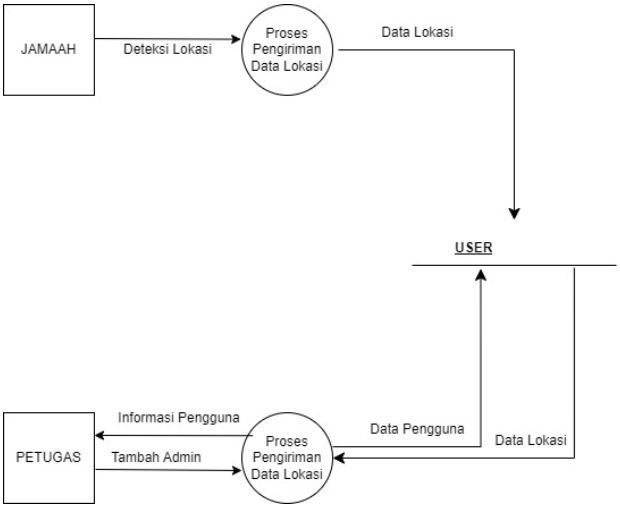

Figure 11
DFD Level 2 Location Search

c. Results of Tool Implementation

In this test, the data process from the device to the database and the reading of the data from the database has been successful. Here's the test:

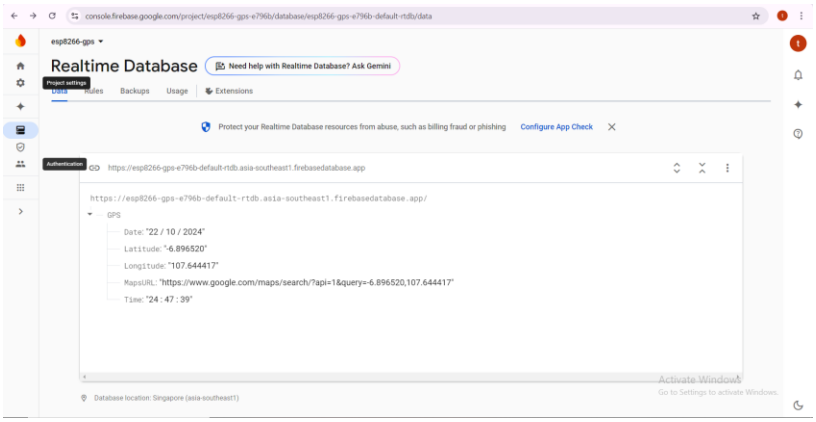

Figure 12
View of data reads from the database

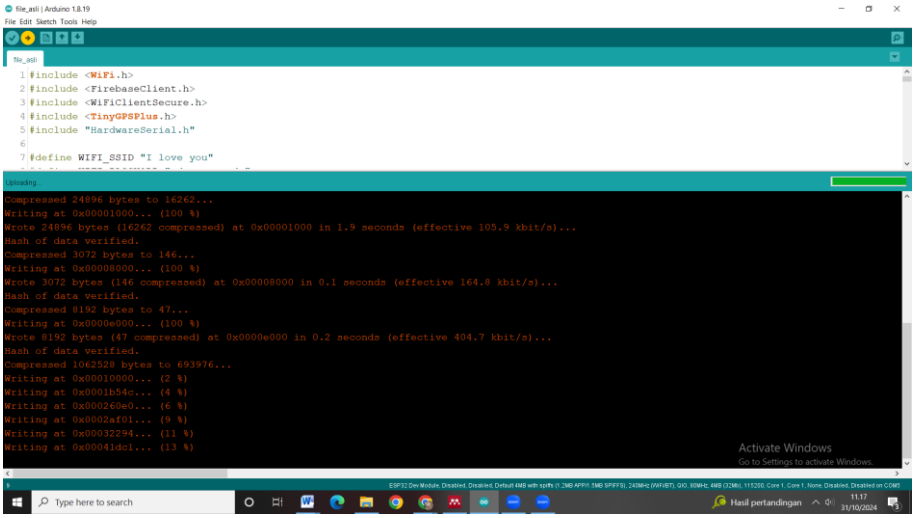

Figure 13
View of the Upload Process from Arduino idea to Firebase

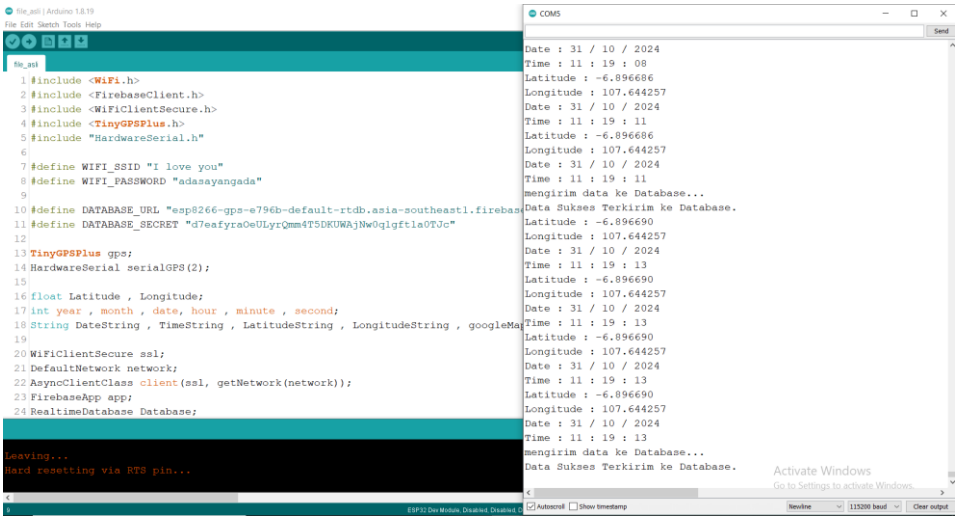

Figure 14
Display Results of data upload on Arduino ideas to Serial Monitor

In the image, coordinate data is obtained including latitude and longitude, date and time stamp, and map URL. Data that has been configured by ESP8266, will be passed to Firebase for storage.

d. Hardware TestingHardware testing aims to test the functionality of this monitoring tool.

Table 13
Hardware Testing

Hardware	Function	Indicator	Status
NodeMcu	As the main control of the tool's process, it retrieves *timestamp* data and sends the data to the database.	NodeMCU can obtain time data	Succeed

GPS Ublox Neo 6M	Collecting *latitude* and longitude data as well as data *speed*	GPS can obtain coordinates and Speed data	Succeed

Software Testing

Software Testing aims to find out the state status of the monitoring tool that can function properly.

Table 14
Software Testing

Hardware	Function	Status
Arduino IDE	Can *input,* and *run* programs, and can connect with *Firebase*	Succeed
Google Firebase	Can store data sent by NodeMCU	Succeed

Tool Accuracy Testing

The Accuracy Test of the tool aims to display the results of latitude and longitude data on the GPS tool Ublo Neo 6M.

Table 15
Tool Accuracy Testing

No	Coordinate		Distance Difference (m)
	Google Maps	GPS Ublox Neo-6m	
1.	-6.896520, 107.644419	-6.896520,107.644417	2
2.	-6.896520, 107.644419	-6.896520,107.644417	2
3.	-6.896520, 107.644419	-6.896520,107.644417	2
4.	-6.896520, 107.644419	-6.896520,107.644417	2
5.	-6.896520, 107.644419	-6.896520,107.644417	2
6.	-6.896520, 107.644419	-6.896520,107.644417	2
7.	-6.896520, 107.644419	-6.896520,107.644417	2
8.	-6.896520, 107.644419	-6.896520,107.644417	2
9.	-6.896520, 107.644419	-6.896520,107.644417	2
10.	-6.896520, 107.644419	-6.896520,107.644417	2
Total Distance Difference			20
Minimum Distance Difference (m)			2

Maximum Distance Difference (m)	2
Average	2

In the table above, it is obtained that the total difference is 2 meters, with an average difference of 2 meters.

Website Page Views

The display of this website is to display the company's information page in the form of a website:

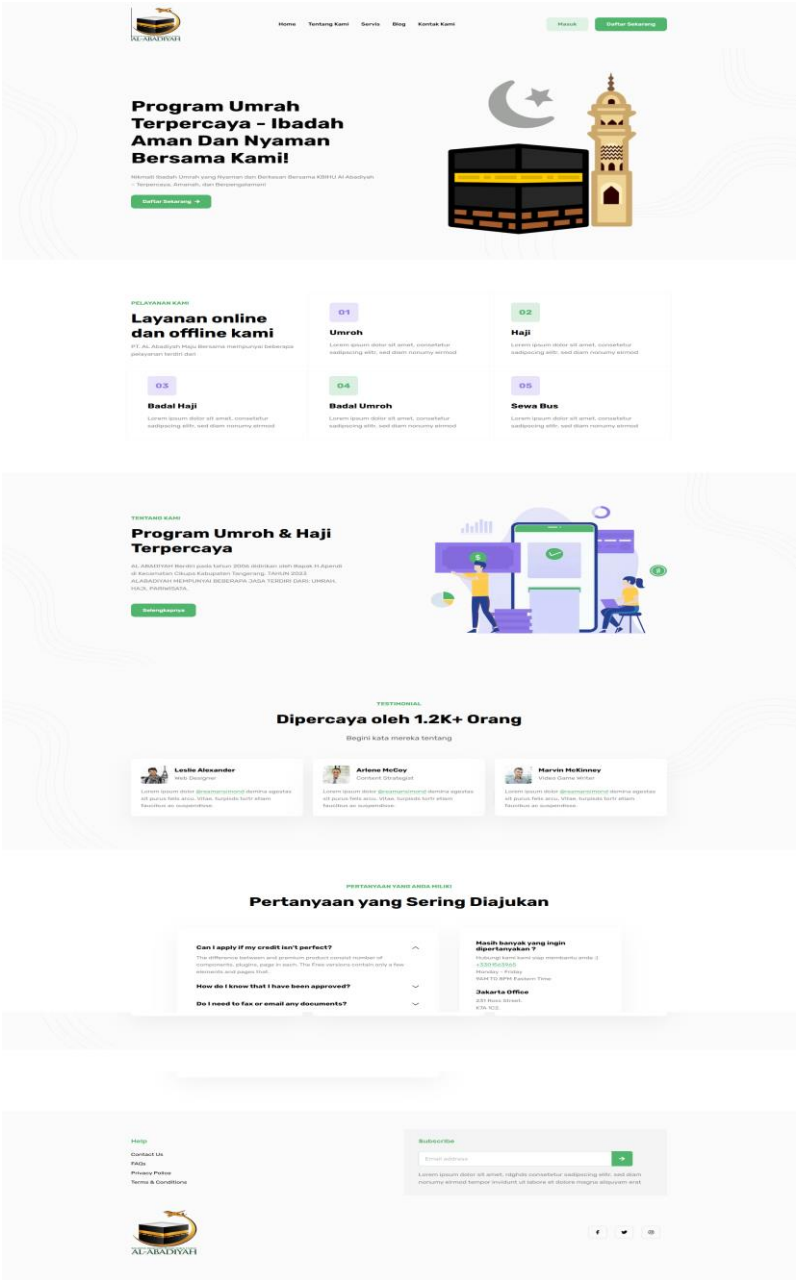

Figure 15
Main Page View

Login & Register Page View

This login and register display is to display the account login page to enter the admin website and the registration page is for account registration in the form of a website:

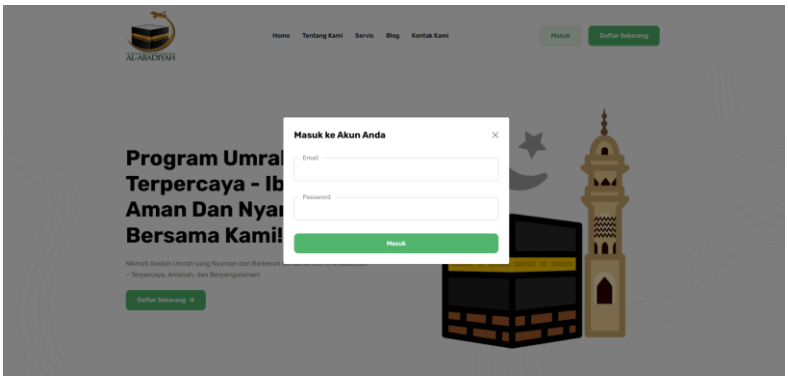

Figure 16
Login Page View

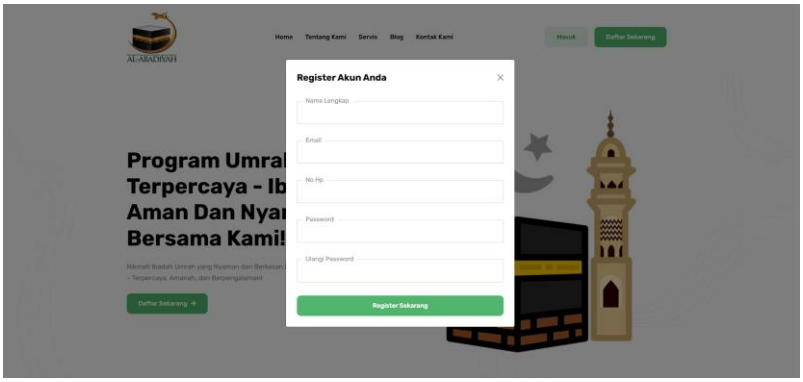

Figure 17
Register Page View

Admin Web Page View

This admin web view is to display the admin page to monitor the location of the pilgrims, update the registration progress by the admin, and monitor the progress of pilgrim registration and pilgrim activities in the form of a website:

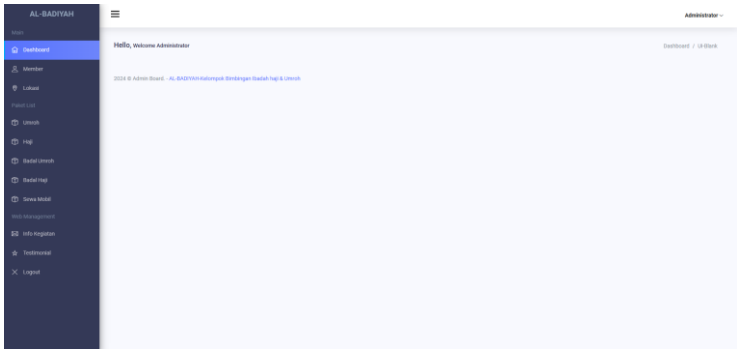

Figure 18. Login Page View

Conclusion

The study concludes that real-time location monitoring using GPS allows Hajj organizers to track participants' locations accurately and promptly, enhancing their safety and mobility management. The integration of IoT devices facilitates data collection on participants' locations and conditions, transmitting this information to a server for web-based system access, requiring a secure and stable configuration for continuous updates. Additionally, the web-based system presents data in a structured and user-friendly manner through clear visualizations like interactive maps and participant condition dashboards, supporting efficient management, logistics organization, and participant coordination.

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