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IOT BASED SMART CHIRUGWI

By

TAKUDZWA P. NYAMUKUVA

Submitted in partial fulfilment of the requirements for the degree

BACHELOR TECHNOLOGY: CAPSTONE DESIGN

In the

Department of **COMPUTER SCIENCE**

SCHOOL OF INFORMATION SCIENCES AND TECHNOLOGY

HARARE INSTITUTE OF TECHNOLOGY

Supervisor: DAVID FADARALIKI

NOVEMBER 2021

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DEDICATION

I'd want to dedicate this paper to my personal mentors, family, and friends for always inspiring and supporting me in all facets of my life. They have inspired me to strive for excellence in everything I do.

Acknowledgements

First and foremost, I'd like to thank Mr. Fadaraliki, my project supervisor, for his direction and persistent supervision, which enabled me to finish this project. I'd want to thank my parents for making it possible for me to pursue my degree in computer science. Most importantly, I'd want to thank the Almighty for providing me with the courage, as well as for making my endeavour a success.

Abstract

The advancement of technology and automation has made everyday living more convenient. This study focuses on the automation of a chicken farm utilizing several sensors, a Bluetooth Module, and the Arduino Uno Micro-controller. Chicken is the most popular produce in today's world since it is a nutrient-dense food with more protein, less fat, and less cholesterol than other poultry. In this study, environmental factors of a chicken farm such as temperature and humidity are monitored and regulated automatically in order to maximize chicken development and product quality. Water level is also adjusted and monitored with the help of ultrasonic sensors. Ammonia and carbon dioxide gasses are monitored using the MQ135 air quality sensor. Using data from the sensors, the person in charge of the chicken farm can obtain information on the farm's internal environmental state by accessing the internet on a PC or a mobile phone. This system will manage temperature, humidity, gasses, and water level without human involvement by using a cooling fan, heater, and a water pump. It will turn on the gadgets based on the threshold values. As a result, this technology automates chicken farming, minimizes labour requirements, and enhances the output of nutritious chicken.

Keywords: Chicken, Automation, Water level, Ammonia.

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Chapter 1: Proposal

1.1 Introduction

The chicken poultry industry is crucial to Zimbabwe's long-term food security. As a result, there is a greater awareness of the health of chickens as well as the quality of their products. Many issues emerge while caring for chickens since it is a time-consuming and an intricate operation that requires vigilance and the minimization of mistakes. To address these issues, an IoT-based Chicken Farm may be built utilizing a basic micro-controller, such as the Arduino Uno, and a few sensors, such as temperature, humidity, and air quality sensor.

1.2 Motivation

Farmers lose a lot of money as countless chickens don't make it to the market because of basic factors like excessive temperatures, insufficient brooder ventilation, and uncontrolled ammonia and carbon dioxide gasses. Chickens require specific temperatures because if the atmosphere is too hot, they will not be able to eat, and if it is too cold, they will gather and stop feeding. In the existing system, human labour is necessary to adjust temperature and other factors. This process is inefficient since humans are not accurate, resulting in the deaths of numerous birds and financial losses. Controlling light, feeding, and watering the birds all need a lot of human interaction, which makes farm work tiresome and inefficient. All of these chores can be simplified and completed more efficiently thanks to the Internet of Things.

1.3 Related Work

Several previous studies on this topic have been conducted. Sneha. M. carried out the preliminary research, which included integrating wireless sensors and mobile networks to regulate and monitor the livestock environment. The DHT22 sensor module was used to detect the humidity and temperature levels in the air. As a result, the serial monitor displayed all temperature and humidity values sensed by the sensor.

Rupali B. Mahale and S. Sonavane [1] conducted the following study, in which they implemented a method to assess the degree of food availability on chicken farms. The user will receive information on the level of foods and water on the farm via the GPRS network, according to the findings of this study.

In a separate study, Rupali B. et al. combined the WS (Wireless Sensor Network) and GPRS (General Packet Radio Service) networks to automatically monitor ammonia levels. In this study, the MQ135 sensor is used. The ammonia threshold is 40%, and if the sensor detects this value, the fan will start immediately.

In another study, So-In C, et al. proposes a hybrid mobile environmental and population density management system for smart poultry farms. So-In C, et al. focus on using a sensor network and mobile devices to control and monitor environmental parameters in a chicken poultry farm remotely. By sending an SMS to the owner's registered mobile number, this system allows the owner to monitor various environmental related parameters such as temperature, humidity, and so on. The owner can initiate a required action by sending a message back to the system, and if the system does not receive a command within a certain time period, it will automatically initiate the action.

1.4 Problem Statement

Farmers lose a lot of money due to chicken deaths caused by uncontrolled environmental factors such as temperature, humidity, and gasses i.e., ammonia and carbon dioxide. Controlling the parameters using human labour is inefficient and unreliable. By using an IoT-based chicken farm, farmers may decrease chicken deaths and financial losses.

1.5 Aim

The goal of this study is to create an IoT-based chicken farm for broiler production. The system should be able to automate the majority of broiler production activities in order to reduce financial losses incurred by farmers due to human errors. The designed system should automate the temperature, humidity, and water level maintenance in a chicken coop. All of this is to be accomplished with Arduino and a variety of sensors, such as ultrasonic sensors and air quality sensors.

1.6 Technical Objectives

To develop a system that:

1. monitors and maintains temperature and humidity in a chicken coop.
2. monitors the quality of air in the chicken coop.
3. automates the provision of water to the broilers.
4. includes a dashboard for chicken batch management.

1.7 Justification

In the current system, human labour is required to monitor and maintain environmental factors such as temperature and humidity. This method is inefficient since humans are inaccurate, resulting in the deaths of many birds, stunted growth, and financial losses. Farmers are currently having difficulty tracking the build-up of ammonia gas in the chicken coop, which causes diseases that reduce the quality of the birds' meat. Implementing IoT in broiler chicken farming helps to mitigate some of the losses that farmers incur. The "IoT Based Smart Chicken Farm" will automate some of the activities, such as monitoring and managing temperature and humidity, monitoring gas build-up, and automating the provision of water to the broilers. This eliminates the majority of human involvement, making chicken farming more efficient.

1.8 Research Methodology

The research methodology is crucial in carrying out the entire research study. It is critical to conduct extensive research in order to fully meet the requirements of the project's various stakeholders. This area is covered by data and information gathering; various techniques are used concurrently to gather enough information before proceeding with the project. The research methodology assists us in becoming fully aware of the research problem statement and mitigating the research objectives.

Because of the nature of the research, the researcher decided to use qualitative research methods. It is critical to collect information on the current methods being used in the field of study and to conduct research on the various aids that are available, their adoption into the system, and their affordability. The information gathered is in charge of outlining an accurate and complete description of how the system should function and the challenges it should be able to overcome.

Listed below are the methods used in gathering information:

- Interviews – The author went around farms asking farmers questions about broiler production and what problems they were having. This helped to identify the functions the system should include.
- Observation – The researcher gathered information by observing how farmers currently perform tasks in chicken production.
- Document Analysis – Reading various journals, articles, and research papers yielded information.

1.9 Proposed Tools

Hardware

- Arduino Uno
- Bluetooth Module
- Ultrasonic Sensor
- Air Quality sensor
- Relay Module
- Heater
- Fan
- Submissible water pump

Software

- Firebase for backend
- HTML, CSS, Vanilla JavaScript, ReactJS and Bootstrap for front end.

1.10 Expected Results

A system that:

1. automates the monitoring and maintenance of temperature and humidity in a chicken coop.
2. monitors gas build-up and air quality in a chicken coop.
3. automates the provision of water to the broilers.

1.11 Time Table

TASK NAME	October	November	December	January	February	March	April	May	June
Proposal									
Data Collection									
Literature Review									
Design									
Analysis									
Implementation									
Testing									
Reporting									
Documentation									
Submission									

1.12 Conclusion

The Smart Chirugwi system was introduced in this chapter. The background of the project idea, the problem statement, the project's aim and objectives, the methodology for carrying out the project, and what will be covered by this work are all covered.

Chapter 2: Literature Review

2.1 Introduction

This study's literature review focuses on similar studies that have been conducted on the challenges and problems that farmers face in trying to maintain optimal environmental conditions and water supply in chicken production. This chapter explains what other researchers in a similar field of study have done in order to put this research in context.

2.2 Synthesis of literature

2.2.1 Smart Poultry Farm: An Integrated Solution Using WSN and GPRS Based Network

Mahale and Sonavane (2016) propose a model which includes Food and Water Level Control Mechanism for Smart Poultry Farming. They focus on the use of wireless sensors and mobile system networks to remotely monitor and control environmental parameters in poultry farms. The goal is to regulate temperature and humidity levels in the environment. The responsible person can be able to get the information about the internal environment of poultry farm by receiving a message on his mobile number. Water level and food control mechanisms are also designed using sensors in this system. According to Mahale and Sonavane, the quality of the food fed to the chickens affects the quality of the chicken products. To get a detailed view of the chicken farm environment, a webpage is used. This study is a success in terms of temperature control, but it is limited in that it does not automatically supply food or water, relying instead on manual refills.

2.2.2 Smart farm monitoring using Raspberry Pi and Arduino

Jindarat and Wuttidittachotti (2015) propose an Intelligent System that uses Embedded Systems and a Smart Phone to deal with supervision and problem elimination on a poultry farm. The Raspberry Pi and Arduino Uno microcontrollers are used in this research. The system's primary function is to monitor environmental parameters such as humidity, temperature, and climate quality. A filter fan regulates these aspects of the poultry farm's environment. The system is deemed suitable and simple to use by farmers, despite the fact that it does not allow for continuous water supply for better chicken growth.

2.2.3 A hybrid mobile environmental and population density management system for smart poultry farms

So-In C, et al. (2014) focus on using a sensor network and mobile devices to control and monitor environmental parameters in a chicken poultry farm remotely. By sending an SMS to the owner's registered mobile number, this system allows the owner to monitor various environmental related parameters such as temperature, humidity, and so on. The owner can initiate a required action by sending a message back to the system, and if the system does not receive a command within a certain time period, it will automatically initiate the action. As a result of the system's design, an efficient automated and smart poultry farm monitoring system is available. Goud and Sudharson (2015) also propose the use of wireless sensors and a mobile system network to control and monitor the poultry farm remotely. The poultry owner can use his or her mobile phone to receive information about the weather conditions on the farm. To complete an action, the owner can resend the message to the system to finish a failed task. Data from remote sensors is sent to a server and displayed in Google spreadsheets.

2.2.4 Wireless Sensor Networks Applied on Environmental Monitoring in Fowl Farm

Fangwu Dong and Naiqing Zhang proposed the real-time monitoring requirement of poultry farms on the environment, and an online monitoring system based on ZigBee module is designed for poultry farms on the environment. It will provide a network of real-time monitoring system, which includes node controller, data receiver, data transmission, and control node, all of which are TI's CC2430 based on ZigBee interface technology. To detect different environmental parameters, CO_2 sensors use TGS4161, while temperature and humidity sensors use SHT75. The data transmission protocols and communication formats of the system were designed after an analysis of the system's data transmission and the simplification of the ZigBee protocol stack.

2.2.5 Design of an Intelligent Poultry Feed and Water Dispensing System Using Fuzzy Logic Control Technique

According to O. M. Olaniyi et al., the low cost of production and high human involvement in poultry farms may result in low profit and return on investment. These flaws in the poor chicken feeding system prompted this work, which involved developing an intelligent fuzzy logic-based system that could mimic the roles of poultry labourers in delivering water and feed food to birds at predetermined time intervals. The designed system senses water and feed levels and dispenses intelligently in response to variations in water and feed levels as the chicken consume the water and feed. This system reduces the workload of poultry attendants, increases cost savings, and generates a good return on investment in the poultry farming system.

2.2.6 PLC Based Poultry Automation System

Rupesh I. Muttha, et. al discovered that poultry farming is currently done manually, preventing farmers from reaping the full benefits. A few years ago, feeding whole cereals to chickens as a scratch feed or as part of a complete diet was common practise. With the expansion of large poultry production, automatic feeding systems, which primarily used full-fed complete diets, became the feeding method of choice. One of the major tasks is to control and monitor environmental parameters related to a poultry farm in order to ensure complete chicken care. The goal is accomplished through the use of a sensor-based system. Poultry farming must be environmentally controlled through automation using PLC. These Environmentally Controlled Poultry Sheds are monitored 24 hours a day, seven days a week. It will produce better results while reducing man-hours and human errors.

2.2.7 Wireless sensor network: A complete solution for poultry farming

Ammad-Uddin, et al. (2014) developed a well-thought-out solution for poultry farming. To begin, the authors investigated the control and monitoring of poultry diseases using a wireless sensor network in a modern rooster farm. This wireless network's solutions for poultry farming can establish an ideal farm with maximum productivity and economy. The anticipated solution employs a wearable wireless sensor node, which could be used to detect outbreaks of infected roosters. Furthermore, the wearable sensor nodes, as well as the fixed sensor nodes in the shed and the soil, improve the farm's overall production, quality, and economy.

2.3 Conclusion

Several concepts were examined in this chapter, as well as previous applications. It became easier to deduce some opportunities that could only be derived from a clear and thorough analysis of existing research and systems. These identified opportunities provide a platform for innovation in order to create a better product.

Chapter 3: Requirements Analysis

3.1 Introduction

This chapter examines and assesses the proposed project to see if it is technically, economically, and operationally feasible. The primary goal of this research is to provide a comprehensive understanding of all project-related factors and to determine whether the time and resources invested will yield the desired results. The analysis of requirements is critical to the success of a development project. Requirements must be actionable, measurable, testable, relevant to identified business needs or opportunities, and detailed enough for system design. These specifications can be functional or non-functional.

3.2 Current system

The current system being used in Zimbabwe is based on human labour to control all the activities in a chicken coop. Processes like measuring temperature and humidity, supplying water and feeding the birds a done manually by humans. This process is inefficient since humans are not accurate, resulting in the deaths of numerous birds and financial losses. Since controlling light, feeding, and watering the birds all need a lot of human interaction, this makes farm work tiresome and inefficient.

3.2.1 Context Level Diagram

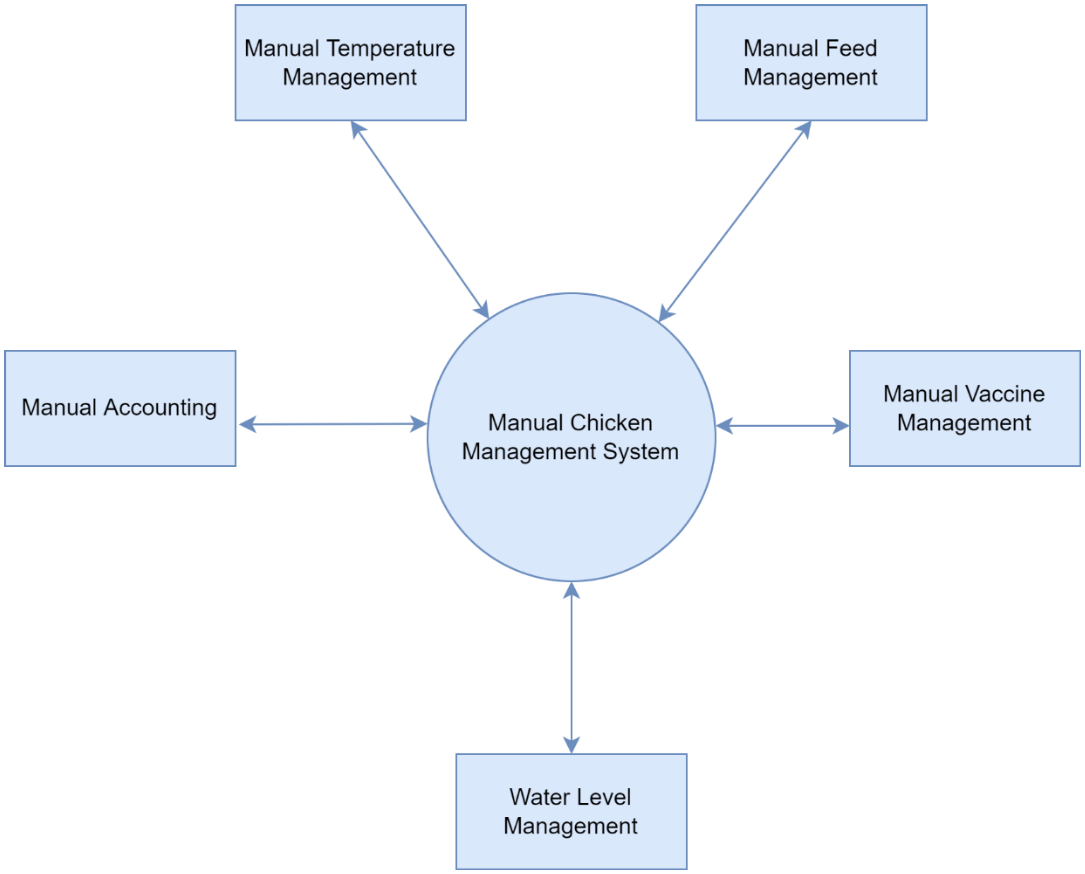

Figure 1: Context Level Diagram of the current system

3.2.2 Process Flow Diagram

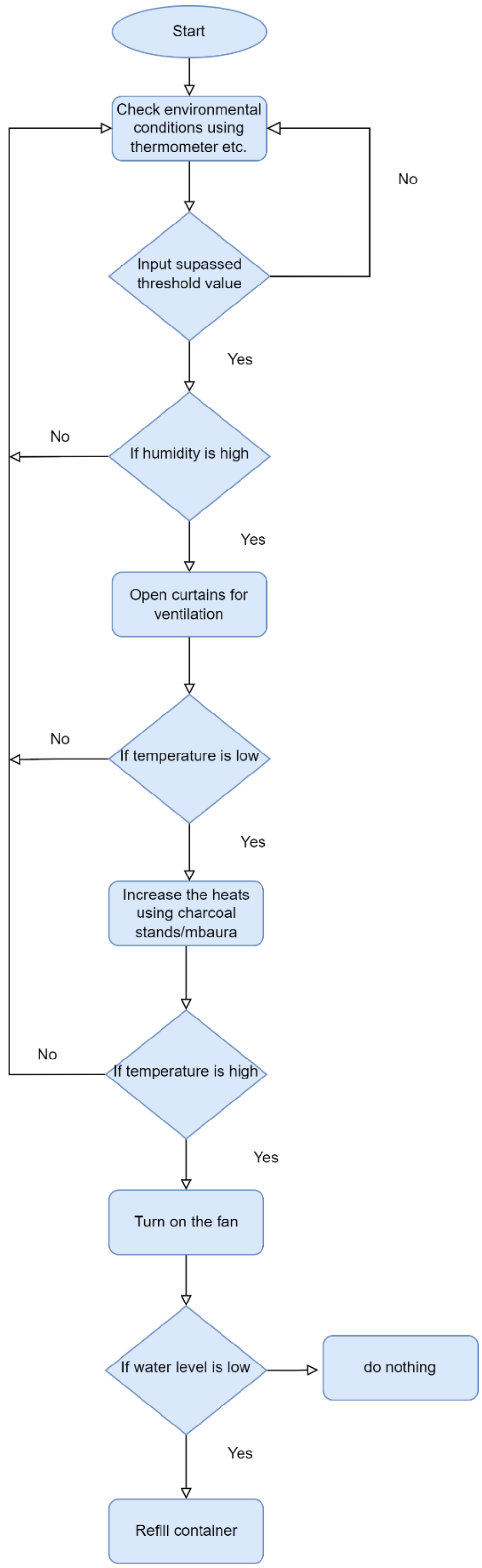

Figure 2:Process Flow Diagram of the current system

3.2.3 Use Case

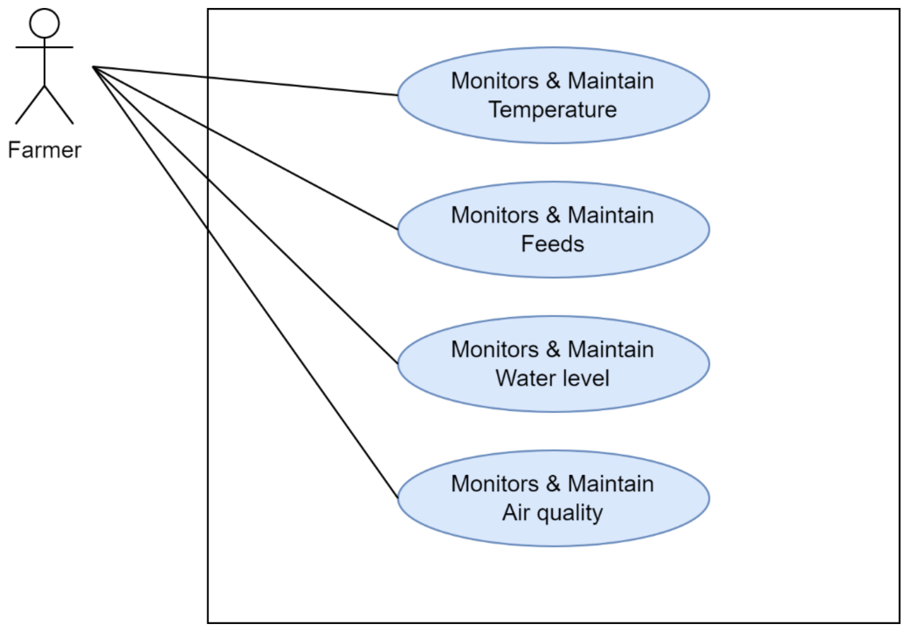

Figure 3:Use Case for the current system

3.3 Feasibility Study

A feasibility study was conducted to determine how the project's objectives can be met successfully while accounting for internal and external influences such as economic, technological, legal, and time constraints.

For this project, the factors considered include the following:

- How much financial investment is required in the system's development?
- Is there a market for a system like this that will be repeatable, sustainable, and profitable?
- Are the skills required to develop such a system available?
- Is it possible to verify and prove the technical assumptions?
- Will the project's output be useful and applicable to the intended market segment?

3.3.1 Technical Feasibility

Technical feasibility determines whether the system is technically feasible in terms of hardware, software, and technical expertise to support the project. This valuation is based on a brief overview of system requirements. It is based on the advancement and availability of the project's required technology. Zimbabwe's environment is rapidly evolving in terms of technological integration. Online services are now offering services to Zimbabwe through various channels, making it possible to buy material and equipment directly from other countries. This facilitates the project because the required materials are readily available. The technical knowledge required is only for the system's developer, not the end user, because the end product is a system that does not require technical expertise to operate.

For this system, the required technical skills include the following skills:

- Knowledge in electronics devices and boards (Arduino)
- Knowledge in programming languages (C/C++)
- Knowledge in hardware assembly.
- Knowledge in assembly language programming (Arduino language)
- Web front-end technologies (HTML5, CSS, Bootstrap, ReactJS).
- Firebase for backend

3.3.2 Economic Feasibility

Economic feasibility determines whether the benefits of the proposed system outweigh the projected costs, which are typically based on the total cost of procurement and maintenance. The assessment's goal is to determine the positive economic benefits to the end user and the general public. This includes quantifying and documenting all anticipated benefits. This is typically accomplished through a cost/benefit analysis to determine the net benefit after deducting all costs incurred in developing the project. The proposed system will be able to automate chicken production activities, eliminating human errors. This reduces chicken mortality, making the system extremely beneficial. Because the equipment used is less expensive, the overall cost of production is reduced, and thus procurement prices are reduced, benefiting a larger population of farmers.

3.4 Estimated Budget

Table 1: Estimated budget

Component	**Cost (USD $)**
Bread Board (Mini)	10
Arduino Uno	25
Bluetooth Module	10
Ultrasonic Sensor	10
Air quality sensor	10
Heater	10
Fan	5
Water pump	10
Relay Module	10
Total	**100**

3.5 Requirements Analysis

This project's requirements analysis included functional and non-functional requirements.

3.5.1 Functional Requirements

The basic operations that the system must provide are referred to as functional requirements. They specify how the system should respond to specific inputs and how it should function in specific situations. These can also represent what the system might be unable to do in response to a given input. By categorising the important tasks or activities that must be completed, functional requirements clarify what needs to be done.

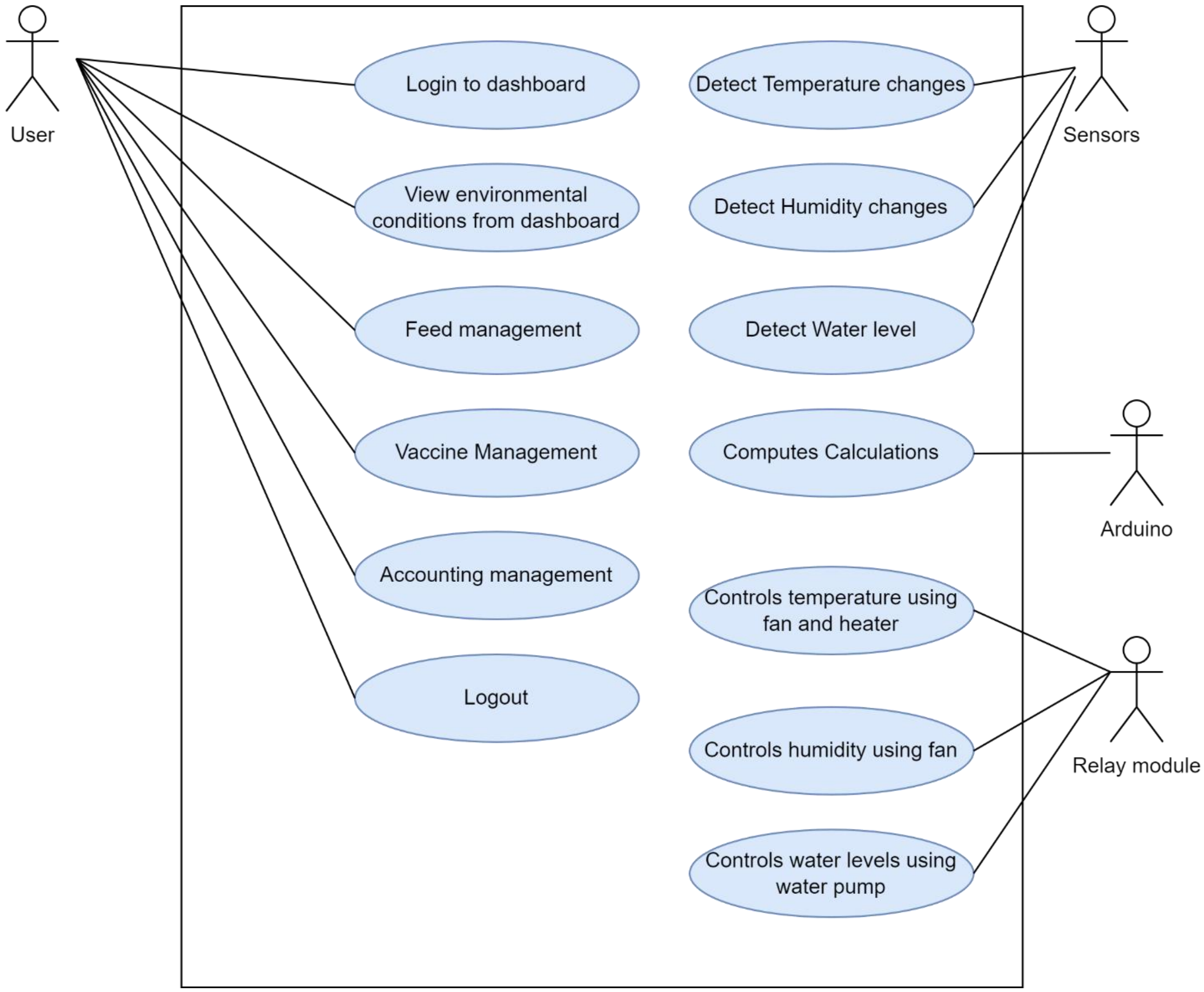

Figure 4:Use case diagram for the proposed solution

3.5.2 Non-functional Requirements

Non-functional requirements define standards that can be used to assess a system's performance. 13 Non-functional requirements, which are constraints on system implementation, such as the capabilities of input/output devices or the data representations used in interfaces with other systems, can be regarded as value features of a system. They may also be used to develop system properties such as reliability, response time, and storage utilization.

3.5.2.1 Performance

This defines the adaptability of the system to detect any minor changes in the chicken coop. The sensors used in the system should have a fast response time such that the farmer gets real-time data.

Cost - Due to the current economic situation, the Smart Chirugwi should be made up of minimal possible components so as to reduce overall cost of production.

Response time - The system should respond quickly to user actions.

Accessibility - Users will be able to access the system via various power sources.

Dependability - that the system's operations should be consistent, efficient, and accurate.

3.5.2.2 Usability

The system should be usable by users with limited computing skills. The interface should be simple to use, with minimal user input but maximum system output.

3.5.2.3 Security

The dashboard part of the system offers great security. In order for users to view data they must be authenticated first. User accounts are isolated hence users only see their own data.

3.6 Technical Requirements

The technical requirements are outlined as follows; the system should be able to:

- Monitor and maintain temperature and humidity levels in a chicken coop.
- Monitor the air quality in a chicken coop.
- Automate the provision of water to chickens.
- Offer a web application for chicken batch management.

Hardware:

- Arduino Uno board,
- 2 Ultrasonic sensors (HCSR04),
- 2 air quality sensors (MQ135),
- Temperature and humidity sensor (DHT11),

- Breadboard,
- 9V Battery,
- Jumper wires,
- Submissible water pump,
- Fan,
- Heater,
- Relay Module,
- Bluetooth Module

Software:

- Arduino IDE
- Language C
- Vs Code
- ReactJS
- Bootstrap

3.7 Assumptions

Some of the assumptions made in this:

- A stable internet connection is available for sending data from the hardware to the dashboard.
- The hardware updates the dashboard with real-time data.

3.8 Conclusion

This chapter covered the tasks involved in determining the needs or conditions to be met, i.e., the new or altered product, while taking into account potentially conflicting requirements. Considering the user's and system developer's technical expertise and knowledge. As a result of requirements analysis, requirements can be functional or non-functional.

Chapter 4: Design

4.1 Introduction

The chapter will highlight the proposed solution's design and methodology, as well as the platform for development, configuration, and deployment. To accomplish this, system architecture and other diagrams such as UML-Activity Diagram, UML-Class Diagram, UML-Sequence Diagram, and UML-Deployment Diagram will be used.

4.2 Proposed Solution

The Smart Chirugwi is a system that consists of both hardware and software components. Smart Chirugwi is a system that monitors and maintains temperature and humidity in a chicken coop, as well as monitors air quality and automates water delivery to chickens. The system includes a web-based dashboard that displays real-time environmental conditions of a chicken coop. The dashboard also includes a feature for managing chicken batches, such as feeds, vaccines, and accounting (profit and loss) for a specific batch of chickens.

4.3 Solution Architecture

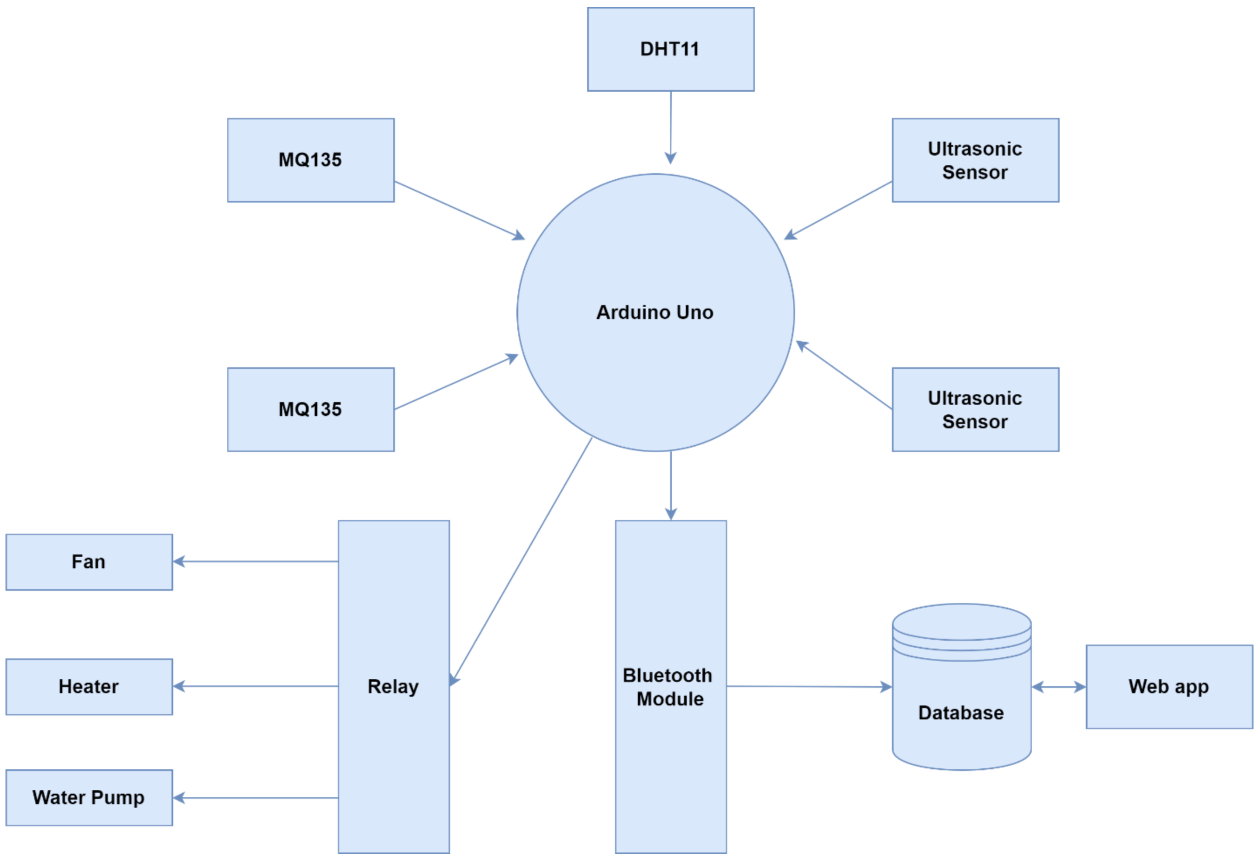

Figure 5: Solution Architecture

4.4 Constraints

- To produce accurate results with water level automation, the sensors must be perfectly perpendicular to the measured surface.
- The MQ135 sensors must be properly calibrated in order to measure air quality and detect gases such as ammonia and carbon dioxide.
- A stable internet connection is required for the hardware to send real-time data to the dashboard.

4.5 Security Design

User Authentication and verification

- Only authenticated users will have access to the system's information, and a user will only see their own information.

4.6 Systems Design Models

The architecture, components, modules, interfaces, and data for a system to meet specified requirements are defined by systems design. Using design models provides a common way to visualise the overall system's design.

4.6.1 UML-Activity Diagram

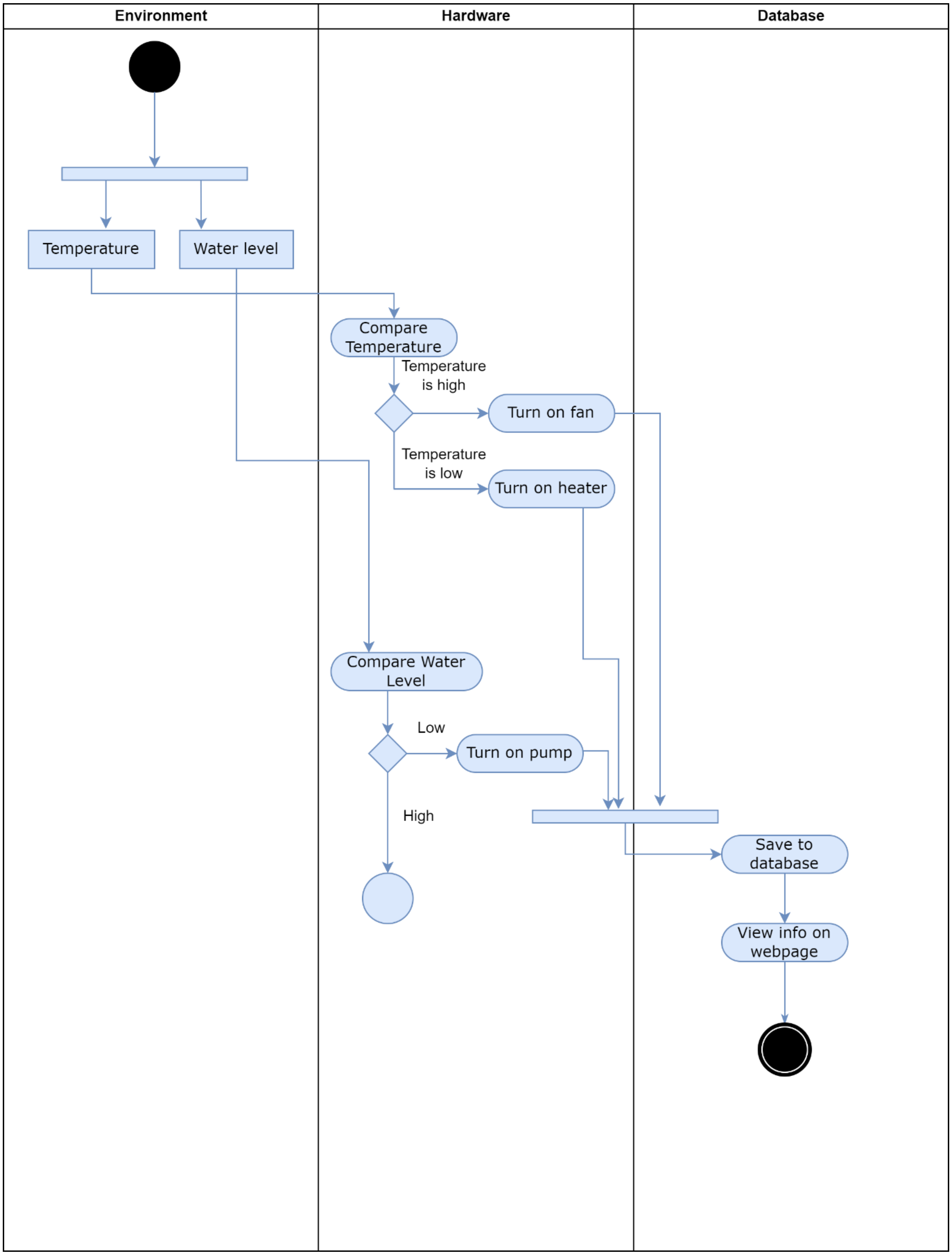

Figure 6:Activity Diagram

4.6.2 UML-Class Diagram

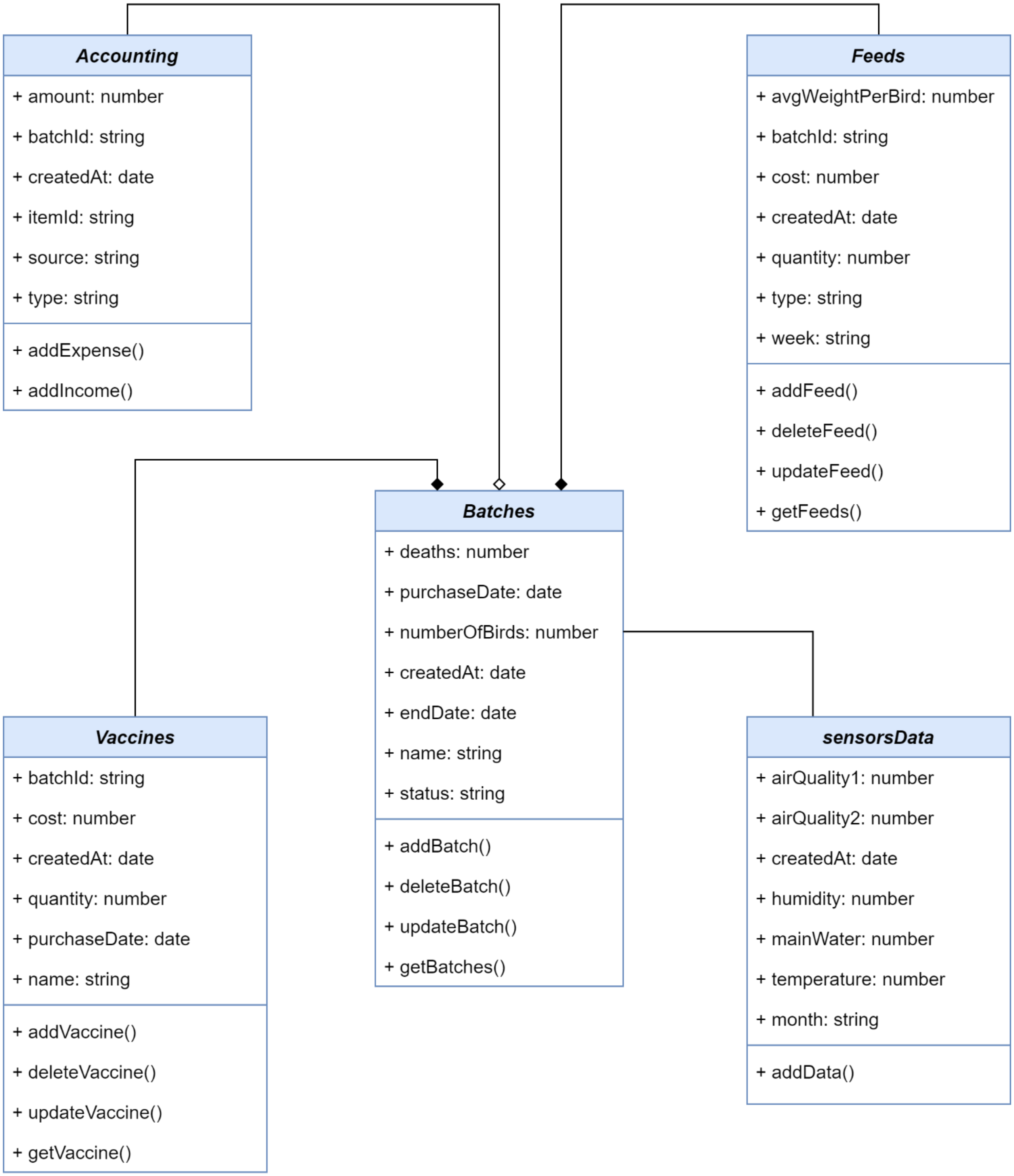

Figure 7:Class Diagram

4.6.3 UML-Sequence Diagram

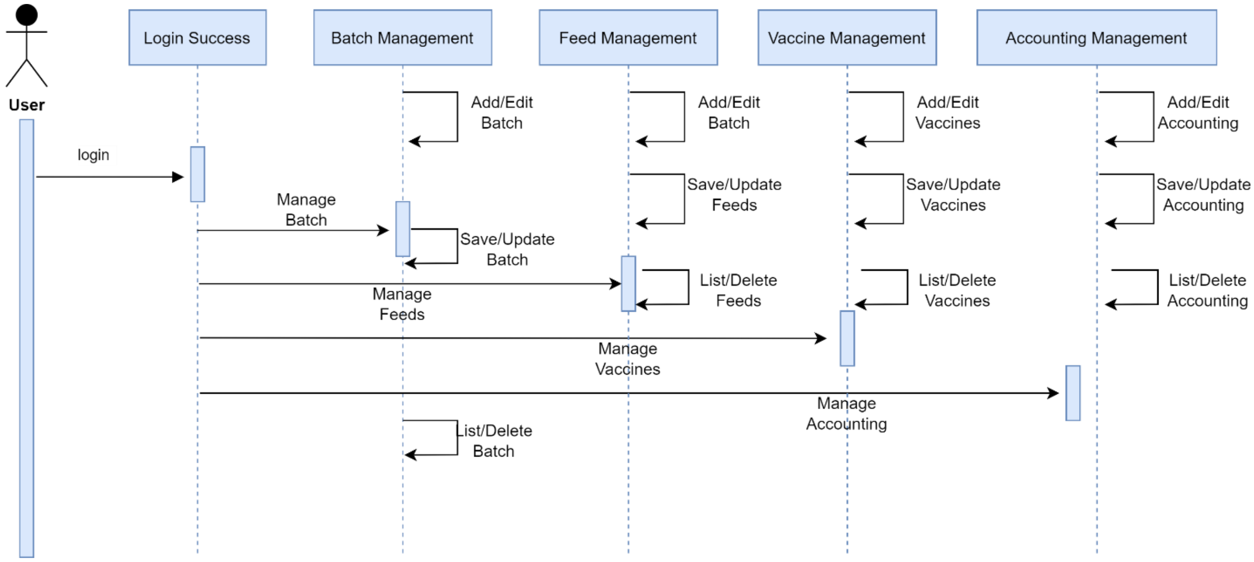

Figure 8:Sequence diagram for Smart Chirugwi Dashboard

4.7 Database Modelling

The database model determines the logical structure of a database and, more importantly, how data can be stored, organised, and manipulated. A NoSQL database was used in the development of Smart Chirugwi.

4.7.1 E-R Diagram

This is a high-level conceptual data model diagram. ER modelling assists in the methodical study of data needs in order to establish a well-designed database. The Entity-Relationship model describes real-world entities and their connections.

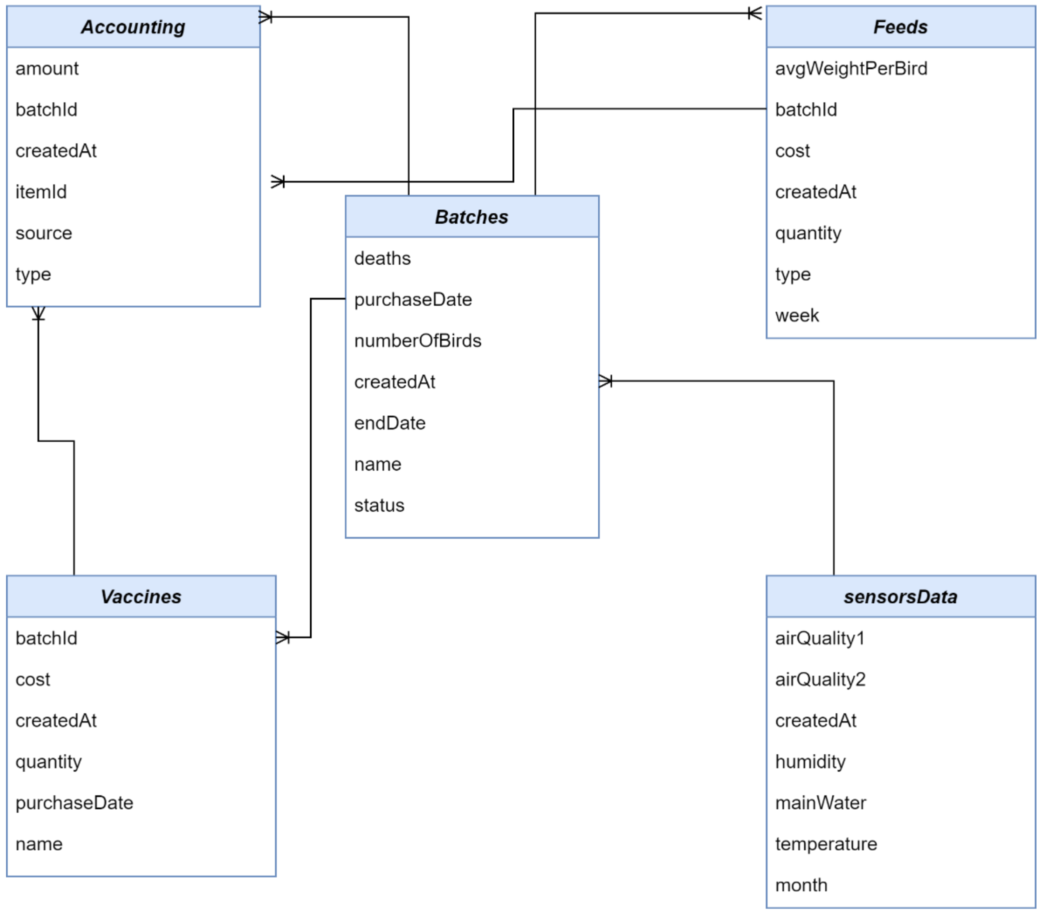

Figure 9:ER Diagram

4.7.2 Data Dictionary

Table 2:Accounting Collection

Column	Data Type	Description
amount	float	Amount of the accounting entry.
batchId	string	ID for the batch the entry belongs to.
createdAt	date	Date created.
itemId	string	ID for the item i.e., vaccine or feed.
source	string	Source of accounting entry.
type	string	Type of entry either Expense or Income

Table 3:Batches collection

Column	Data Type	Description
deaths	int	Number of deaths per batch of chickens.
purchaseDate	date	Date the batch was purchased.
numberOfBirds	int	Number of chicks purchased.
createdAt	date	Date batch was created.
endDate	date	Date batch was closed.
name	string	Batch name.
status	string	Status, i.e., Active or Closed.

Table 4: Feeds Collection

Column	Data Type	Description
avgWeightPerBird	float	Average weight per bird.
batchId	string	ID for the batch the feeds belong to.
cost	float	Cost of feeds.
createdAt	date	Date feeds were created.
quantity	float	Quantity in kgs.
type	string	Type of feed e.g., starter feed.
week	string	The week the feed was used.

Table 5:Vaccines collection

Column	Data Type	Description
purchaseDate	date	Date vaccines were purchased.
batchId	string	ID for the batch the vaccines belong to.
cost	float	Cost of vaccines.
createdAt	date	Date vaccines were created.
quantity	float	Quantity in litres.
name	string	Vaccine name.

Table 6:Sensor data collection

Column	Data Type	Description
airQuality1	float	Air quality from gas sensor 1.
airQuality2	float	Air quality from gas sensor 2.
month	string	Month.
createdAt	date	Date created.
humidity	float	Humidity.
mainWater	float	Water level for the main reservoir.
waterLevel	float	Water level for the drinker.

4.8 Interface Design

The user interface serves as a bridge between the system and the user. The dashboard is used by the Smart Chirugwi system to communicate with the user.

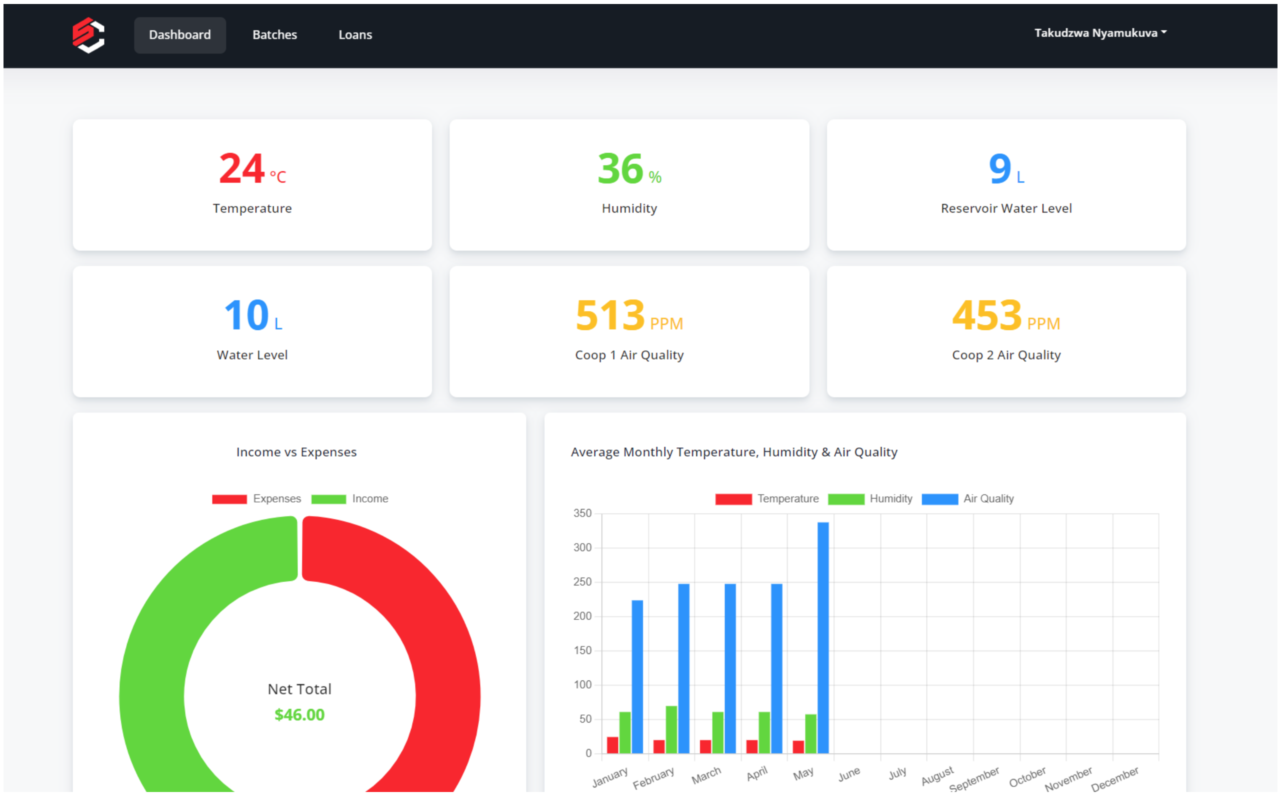

Figure 10: Smart Chirugwi Dashboard

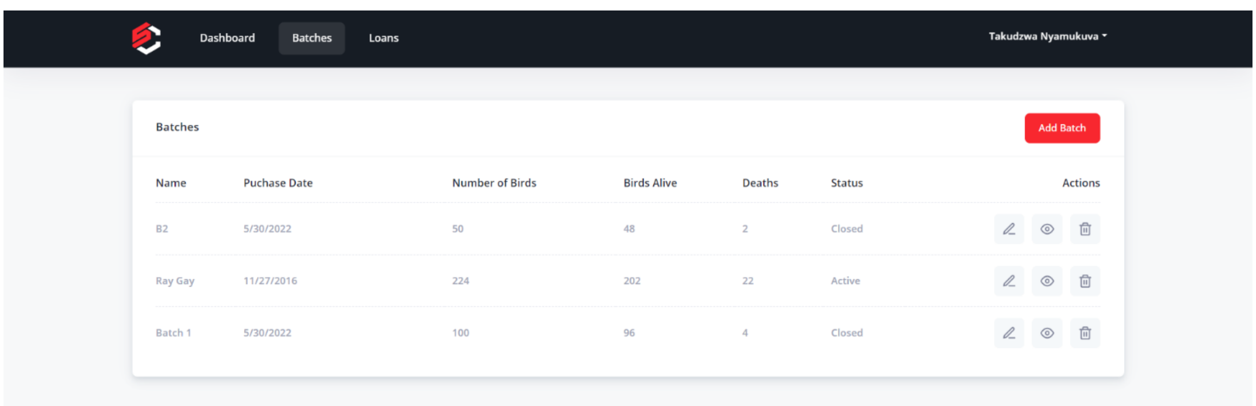

Figure 11: List of all the batches

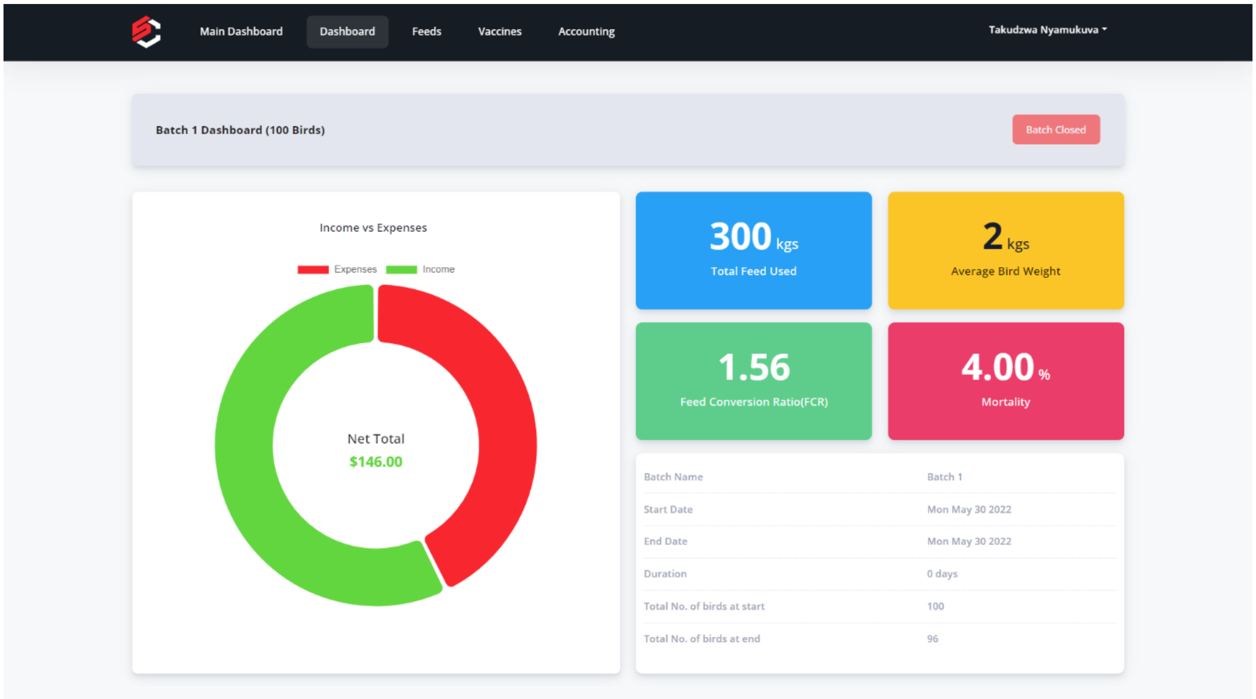

Figure 12: Dashboard for an individual batch

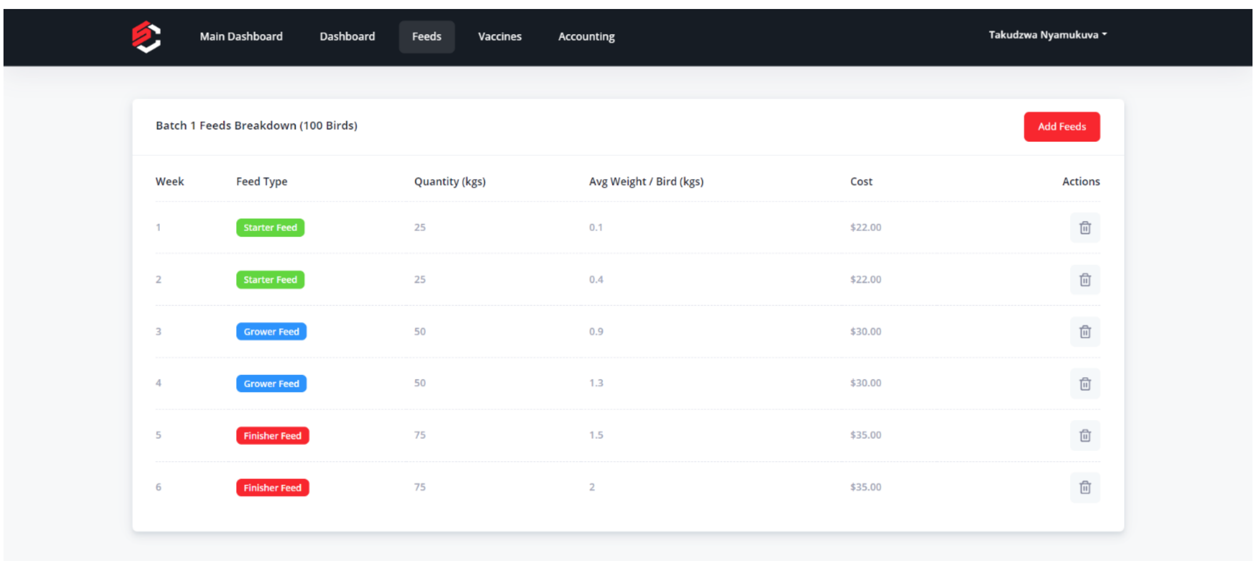

Figure 13: List of feeds per batch

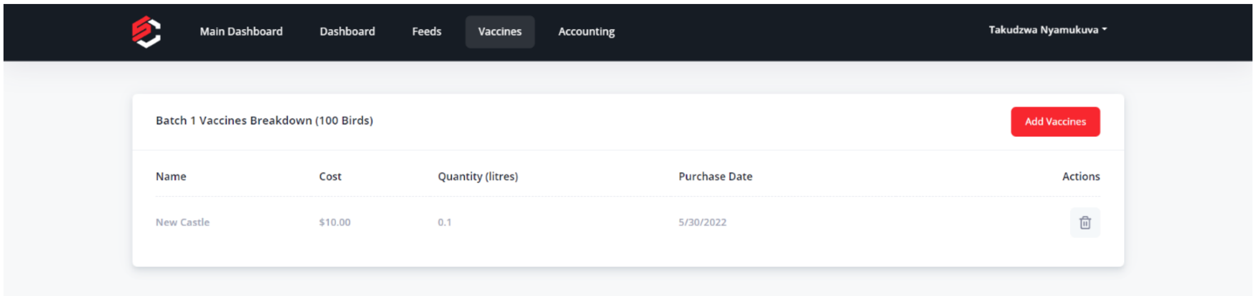

Figure 14: List of vaccines per batch

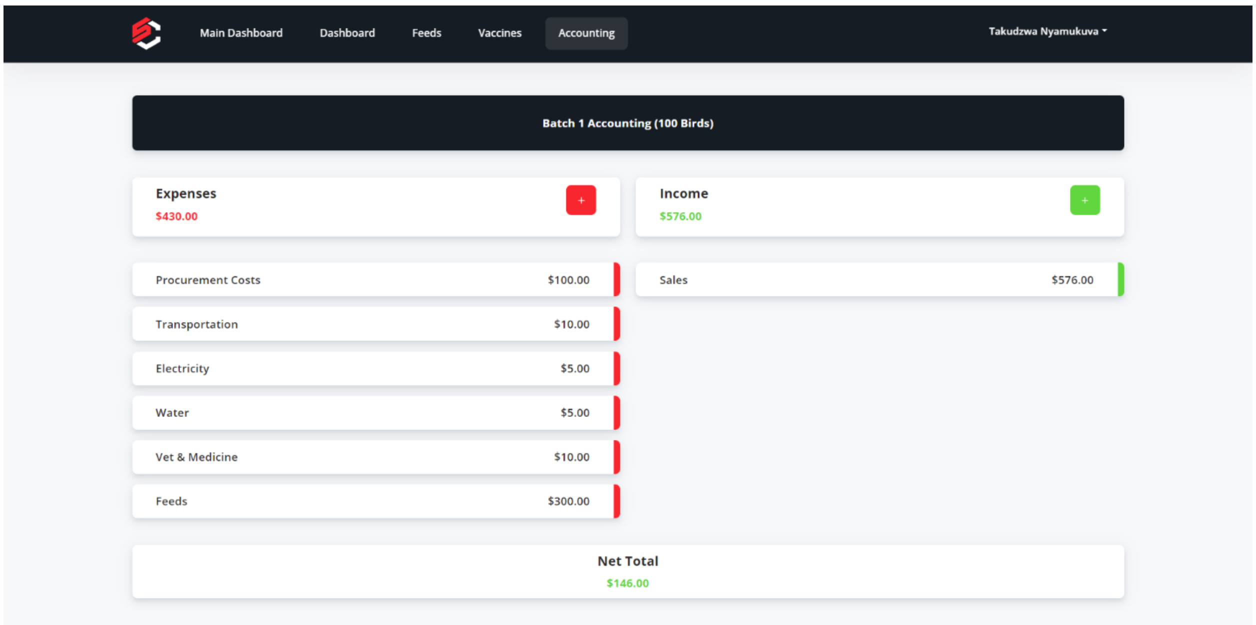

Figure 15: Accounting per batch

4.9 Conclusion

This chapter examined the overall system design process, relating all components to their functionality and demonstrating how the various modules interact to achieve the stated objectives. The system flow was defined as to how each process works and which processes are required before others can begin.

Chapter 5: Implementation

5.1 Introduction

This chapter describes how the previous chapter's designs were turned into operational modules. It examines the hardware used, coding conventions, coding strategies, and coding reviews. It also includes circuit diagrams for the entire system.

5.2 Coding Conventions

This section examines the set of guidelines and principles for the programming languages used in the development of the IoT Based Smart Chirugwi. The programming languages used are C, C++, and ReactJS.

Arduino

The coding conventions used for the Arduino to ensure that the code reader can easily understand it are:

1. Writing the code in the active voice.
2. Use of short, simple, and declarative sentences rather than complex sentences to help the reader understand.
3. Explaining functions conceptually and laying out commands on how to use it step-by-step.
4. Consistency with the terms being used.
5. No use of acronyms or abbreviations that haven’t been spelled out first.
6. Concede to Optimization when necessary

Reasons for the having the above coding conventions

- Having the user concentrating on the information instead of the design by making a predictable look to the code
- Embracing beforehand based assumption which enables the user to rapidly comprehend the code permitting the simplicity of code duplicating and maintenance.
- Indentation for clear view
- Commenting to explain operations

Naming Conventions

- Use of Camel packaging for identifiers. Capitals for first character of class name then camel case for all whatever is left of the characters.

Design Conventions

We underlined the structure of our code by following great format organizing. This makes the code to be effectively read.

Commenting Conventions

- The accompanying advances were taken to guarantee the great code commenting best practices:
  1. We put the comment on a line before the code or after the code.
  2. We utilize (//and/**/) for the commented content.

5.3 Coding Strategy

The coding strategy is a set of steps taken to complete all of the project's objectives. Because of the large size of this project, it was divided into modules. Before creating the database collections, a clear plan of how it would be structured was created. Before creating the classes, the structure and relationships between them were defined. Some of the features were created through trial and error until the desired results were obtained. The hardware part of the system was implemented using a pseudo code that guided all coding activities.

5.4 Coding Review

Code review is the systematic inspection of source code with the purpose of detecting bugs and assessing code quality. Code review also contributes in the preservation of consistency in the design and execution of the system. This review was carried out by some of the writers' colleagues. This code review approach is known as Over-the-Shoulder. It is one of the most straightforward and user-friendly techniques of doing peer code review. When the system was completed, the author asked two qualified colleagues to inspect the code and explain the decisions taken throughout the development process. The considerations examined during the code review are included in the table below, along with the initials of people who participated in the review process.

Table 7: Code Review

Initials	Description	Yes/No
Mr. N Zulu	Comments were descriptive and easy to understand.	Yes
Mr. N Zulu	Variables used in the code were descriptive and not ambiguous.	Yes
Mr. N Zulu	All functions and methods used the same naming convention.	Yes
Mr. N Zulu	The code is logically correct, which means it performs the intended functions and runs correctly.	Yes
Mr. N Zulu	There is proper validation of input values.	Yes
Mr. N Zulu	When errors occur, the code provides a method to recover data.	Yes
Mr. T Mhishi	There is no redundant code.	Yes
Mr. T Mhishi	The code and folder structure are clean and readable.	Yes
Mr. T Mhishi	There is proper exception handling.	Yes
Mr. T Mhishi	Are errors displayed well on the user interface?	Yes
Mr. T Mhishi	Is there a reasonable explanation in the commented code?	Yes

5.5 Hardware implementation

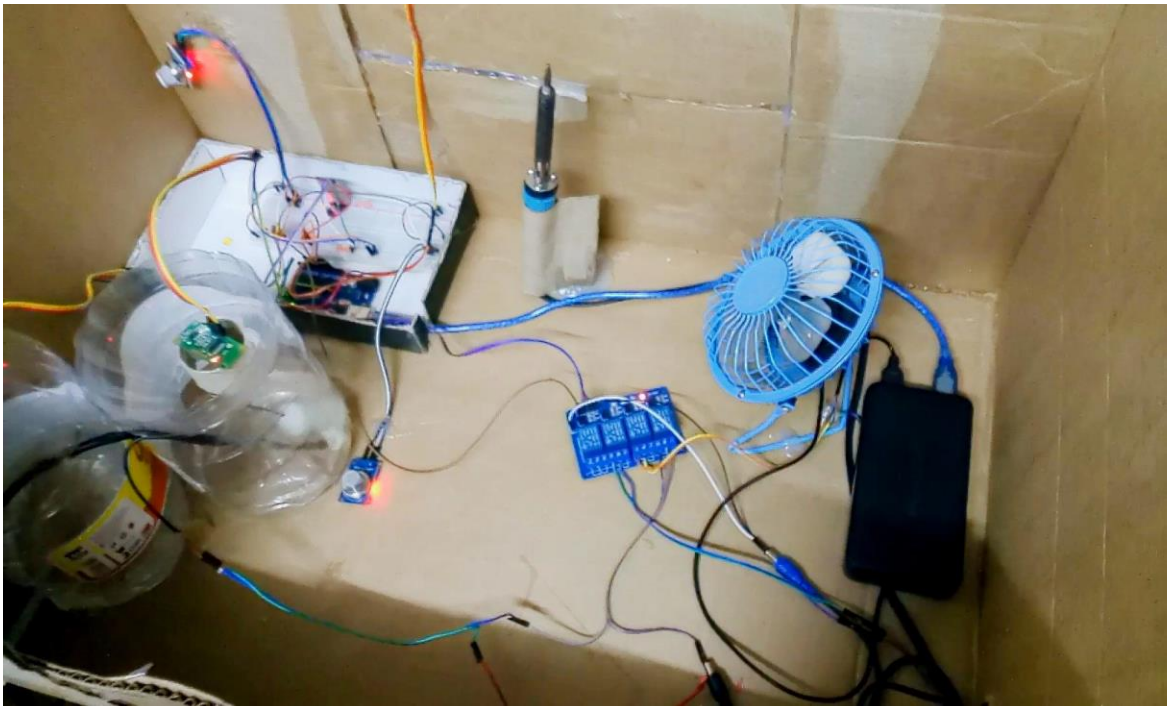

Figure 16: Full implementation of the Smart Chirugwi

The above figure shows the full implementation of the Smart Chirugwi. The figure shows how all the components a connected to come up with one system.

5.6 Conclusion

This chapter discussed how the designs from the previous chapter were turned into operational modules. Examining the hardware, coding conventions, coding strategies, and coding reviews.

Chapter 6: Systems Testing

6.1 Introduction

This chapter focuses on the project's test results and sensor placement based on those results. It includes testing at the unit, integration, and system levels. It includes test cases for both functional and non-functional requirements as outlined in this document's chapter 3.

6.2 Testing Categories and Results

White Box Testing and Black Box Testing are the testing categories used to ensure that the implementation is correct. The test results are shown in the sections below.

6.2.1 White Box

The following are some sample outcomes from white box testing. Keeping the code's design in mind, the following test cases were defined, and the results of the test cases are shown in the tables below.

Test cases for maintenance of temperature

1. Temperature > threshold
2. Temperature < threshold
3. Temperature = threshold

Table 8:Temperature test

Test Case	Temperature	Fan	Heater	Results
1	> threshold	ON	OFF	Success
2	< threshold	OFF	ON	Success
3	= threshold	OFF	OFF	Success

Test cases for maintenance of water level

1. Water level > threshold
2. Water level < threshold
3. Water level = threshold

Table 9:Water level test

Test Case	Water level	Water Pump	Results
1	> threshold	ON	Success
2	< threshold	OFF	Success
3	= threshold	OFF	Success

6.2.2 Black Box

This testing was carried out in order to assess the system's operation without peeking into its core architecture. The system's internal architecture and mechanics were not given significant attention. The emphasis was on the output in relation to the input. Testing was done based on requirements, and the table below with example findings was prepared.

Table 10:Black box test results

Code test scenario	Results
Register a new farmer into the system.	Success
Create a batch	Success
Create Feeds	Success
Create Vaccines	Success
Send reminders in terms of notifications	Success

6.3 Types of Testing and Results

6.3.1 Functional Testing

Functional testing confirmed that the application met all of the criteria. This method of testing replicates actual system operation but makes no assumptions about system structure. To execute system functional testing, test cases were created based on the system's functional requirements.

Table 11:Functional testing results

Functional requirements	**Result**
Allow the farmer to log into the system.	Success
Allow the farmer to monitor coop environmental conditions through the dashboard.	Success
Allow farmer to create batches and manage them in terms of feeds, vaccines, accounting.	Success
Allow the farmer to view batch summary	Success
Alert the farmer reminding them of important events e.g., time to vaccinate chickens.	Success

6.3.2 Non-Functional Testing

Non-functional testing validates system properties such as performance, usability, and robustness. The tests conducted concentrated on testing these non-functional criteria, which reflect on the system's quality. The following test cases were performed on the system's non-functional needs.

Table 12:Non-functional testing results

Domain	Test Case	Results
Efficiency	The system should load immediately.	Success
Usability	All pages should be easy to find.	Success
Security	Only authenticated users can access system resources.	Success

6.4 Test Cases

The key test cases done on Smart Chirugwi are of the system's objectives and other important activities. Various environmental conditions were employed during the test to examine the intended functionality of the system.

Table 13:Test cases

Case #	Test Case	Steps to Execute the Test Case	Expected Results	Actual Results	Status
1	User registration	➢ Fill in information	User created account successfully.	User created account successfully.	Success
2	Fan turns on when temperature is high	➢ Increase temperature in the coop.	Fan turns on	Fan turns on until temperature is normal.	success
3	Fan turns on when humidity is high	➢ Increase humidity in the coop.	Fan turns on	Fan turns on until humidity is in normal range i.e., 50 – 70%	success
4	Water pump turns on the refill water when the level is low	➢ Empty water from the water drinker.	Pump turns on	Water pump turns on until a certain threshold is reached.	success

6.5 Levels of Testing and Results

6.5.1 Unit Testing

Individual components were examined to ensure that they worked properly during unit testing. Separate system components were tested. Each component was tested independently of the other system components. The following test scenarios were run:

Table 14:Unit testing results

Function	**Test case 1**	**Test case 2**
Maintain temperature at optimal	Success	Success
Maintain humidity at optimal	Success	Success
Automate water provision to chickens	Success	Success

6.5.2 Integration Testing

Individual system components were merged to see if they worked well together.

Table 15: Integration testing results

Test Case Objective	**Test Case Description**	**Expected Outcome**	**Result**
Check if the hardware and the software of the system communicate in real-time.	Log into the dashboard. Make changes to the environmental parameters i.e., temperature and humidity and observe what happens.	As parameters change the dashboard should instantly reflect the changes. The fan, heater and water pump must respond accordingly.	Success

6.5.3 Validation Testing

Validation Testing is the practise of reviewing software during or after the development process to determine whether it meets stated business requirements. It was done to guarantee that the product met the criteria of the project. It was also done to demonstrate that the product performed as expected when deployed in the right environment. All system criteria were met, and the system served its function.

Table 16:Validation testing results

Domain	**Expected Results**	**Actual Results**
Functional Testing	➢ The system modules should work as intended. ➢ The system should be simple to use and understand. ➢ The system should display error messages.	As expected,
Integration Testing	All of the integrated modules should function seamlessly together.	As expected,
System Testing	The system components should work as intended	As expected,
Acceptance Testing	The system must satisfy both user needs and system objectives.	As expected,

6.5.4 Systems Testing

System testing was carried out in order to validate the entire and completely integrated system. The approach was carried out with the primary goal of identifying bugs. Smart Chirugwi components were fully integrated and tested, and the entire system functioned as intended.

Table 17: System testing results

Domain	**Expected Result**	**Actual Result**
Black Box Testing	The system should be able to receive user input and provide the intended outcome.	As expected,
Functional Testing	The system components should work as planned and generate the intended results and all the functional requirements must be satisfied.	As expected,
Non-functional Testing	All non-function requirements have been addressed, resulting in a secure and efficient system.	As expected,

6.5.5 Acceptance Testing

This test was done to make sure that the system addressed all the user needs.

6.6 System Evaluation

This was done to evaluate the final system's performance and determine how it is likely to operate in the real world. The produced solution passed the various testing scenarios, and the sample users approved of the system. The majority of users believed that the system is trustworthy, sustainable, and a valuable solution that can be utilised to enhance the way chicken farmers carry out their daily activities.

6.7 Conclusion

This chapter concentrated on the outcomes of the project's testing and the placement of sensors based on these results. It included testing at the unit, integration, and system levels. It includes test cases for both functional and non-functional criteria, as described in Chapter 3 of this paper. Giving an overall evaluation and mitigating recommendations for the deficiencies found in the results.

Chapter 7: Conclusion

7.1 Introduction

A Smart Chicken Farm based on IoT was successfully designed, tested, and results were obtained. The proposed system addresses the issues that farmers face in broiler production. The Smart Chirugwi system was a success; it can monitor and maintain temperature and humidity levels in a chicken coop. The system can also monitor the accumulation of gases such as ammonia in the chicken coop. Smart Chirugwi automates the provision of water to chickens, reducing human error. To top it all off, the Smart Chirugwi system includes a dashboard for monitoring all of the environmental conditions of a chicken coop. The dashboard includes a feature for batch management of broilers, which includes everything from feeds to vaccines to accounting. Notifications are used to remind the user of important events, such as when to administer a specific vaccine or when to change the bedding based on the current air quality. This chapter discusses a number of study findings and recommendations, as well as the study's conclusion.

7.2 Findings

Some findings were observed during the design of the system and they are explained as follows:

- The ultrasonic sensor's distance measurements were affected by the container's height and diameter.
- Any obstruction to the ultrasonic sensor may result in inaccurate measurements.
- Although temperature and humidity are directly proportional, this study demonstrated that temperature can remain constant while humidity rises or vice versa.
- Gas sensors must be properly calibrated and must be deployed in the real world for at least 48 hours for them to function properly.
- The obtained results were consistent with theory, indicating that the study is feasible.
- The developed system is adaptable as it reduces labour and lessens the burdens previously experienced in broiler production.

7.3 Limitations of the system

- The system cannot be used with small containers.
- Feeding of chickens is not addressed by this system.
- Any movement that affects the ultrasonic sensor can result in inaccurate results being produced.
- A loss of water supply to the pump can cause damage to the motor.

7.4 Scope of Future Work

Instead of Bluetooth, a GSM Module or an ESP Module can be used to allow the user to access the data of the chicken coop from anywhere in the world with ease. The Smart Chirugwi can include a security feature for the chicken farm. A security feature can be implemented to ensure that no intruders enter the farm. To eliminate the majority of human errors in broiler production, the Smart Chirugwi can include a feed automation feature.

7.5 Recommendations

When connecting dc motors and other high-voltage components to the Arduino Uno board, an external power supply should always be used; otherwise, the board will be damaged. Furthermore, when working with water and electrical circuits, extra caution is required to avoid a short circuit that will burn out components. As funds allow, the use of different ultrasonic sensors that are more resistant to changes in air temperature and humidity becomes more viable. These would reduce the amount of error recorded in the results.

7.6 Conclusion

This chapter analysed the overall system performance results and identified areas for improvement, stating which factors needed to be considered. It also considered the scope of future work and the technologies that could be used to make the Smart Chirugwi a one-stop solution for chicken farm automation.

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Appendix A: Sample Code

Arduino Code

```
#include <dht.h>
dht DHT;
#define DHT11_PIN 5 //pin for dh11

// defines pins numbers for ultrasonic sensors
const int trigPin1 = 2;
const int echoPin1 = 3;
const int trigPin2 = 6;
const int echoPin2 = 7;
// defines variables for ultrasonic sensors
long duration;
int distance;
int mainReseviourSensor;
int containerSensor;
//MQ135 Air Quality
int sensorValue; //sensor output
int sensorValue1; //sensor output
// defines pins numbers
int buzzerPin = 12;
int relayPin1 = 8; //This is the Arduino Pin that will control Relay #1
int relayPin2 = 9; //This is the Arduino Pin that will control Relay #2
int relayPin3 = 10; //This is the Arduino Pin that will control Relay #3
int relayPin4 = 11; //This is the Arduino Pin that will control Relay #4

void setup() {
pinMode(trigPin1, OUTPUT); // Sets the trigPin1 as an Output
pinMode(echoPin1, INPUT); // Sets the echoPin1 as an Input
pinMode(trigPin2, OUTPUT); // Sets the trigPin2 as an Output
pinMode(echoPin2, INPUT); // Sets the echoPin2 as an Input
pinMode(buzzerPin, OUTPUT);
pinMode(relayPin1, OUTPUT);
pinMode(relayPin2, OUTPUT);
pinMode(relayPin3, OUTPUT);
pinMode(relayPin4, OUTPUT);
Serial.begin(9600); // Starts the serial communication
}
```

```
void loop() {
int chk = DHT.read11(DHT11_PIN);
// main code
//ultrasonic sensors
SonarSensor(trigPin1,echoPin1);
mainReseviourSensor=distance;
SonarSensor(trigPin2,echoPin2);
containerSensor=distance;

//getting air quality sensor value
sensorValue = analogRead(0);       // read analog input pin 0
sensorValue1 = analogRead(2);       // read analog input pin 2
delay(2000);
if(sensorValue>150){
  digitalWrite(buzzerPin,HIGH);
}
else{
  digitalWrite(buzzerPin, LOW);
}
//relay control//
if(mainReseviourSensor > 10){
  digitalWrite(relayPin1, LOW);
}
else{
  digitalWrite(relayPin1, HIGH);
}
if(DHT.temperature>24){
    digitalWrite(relayPin2, LOW);
}
else{
  digitalWrite(relayPin2, HIGH);
}
if(DHT.temperature<20){
    digitalWrite(relayPin3, LOW);
}
else{
  digitalWrite(relayPin3, HIGH);
}
Serial.print(mainReseviourSensor);
Serial.print("|");
Serial.print(DHT.temperature);
Serial.print("|");
Serial.print(DHT.humidity);
Serial.print("|");
Serial.print(sensorValue);
Serial.print("|");
Serial.print(containerSensor);
Serial.print("|");
Serial.println(sensorValue1);

}
void SonarSensor(int trigPin,int echoPin)
{
  // Clears the trigPin
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10 micro seconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
  duration = pulseIn(echoPin, HIGH);
  // Calculating the distance
  distance = duration * 0.034 / 2;
}
```

Appendix B: User Manual

1. User Registration and login

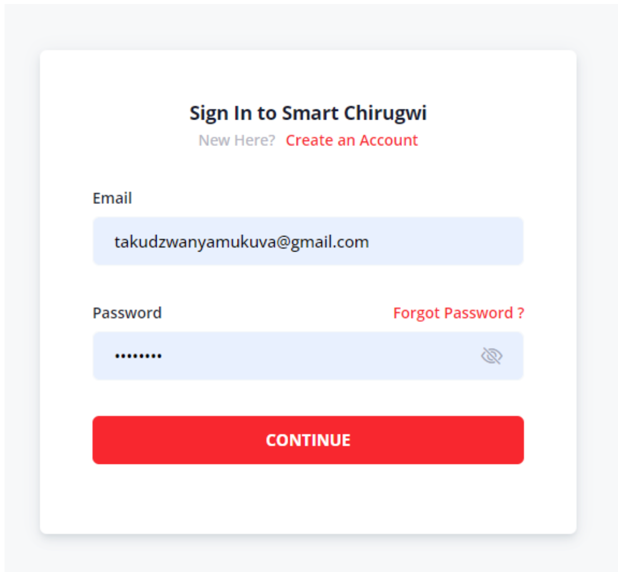

Figure 17:Login Page

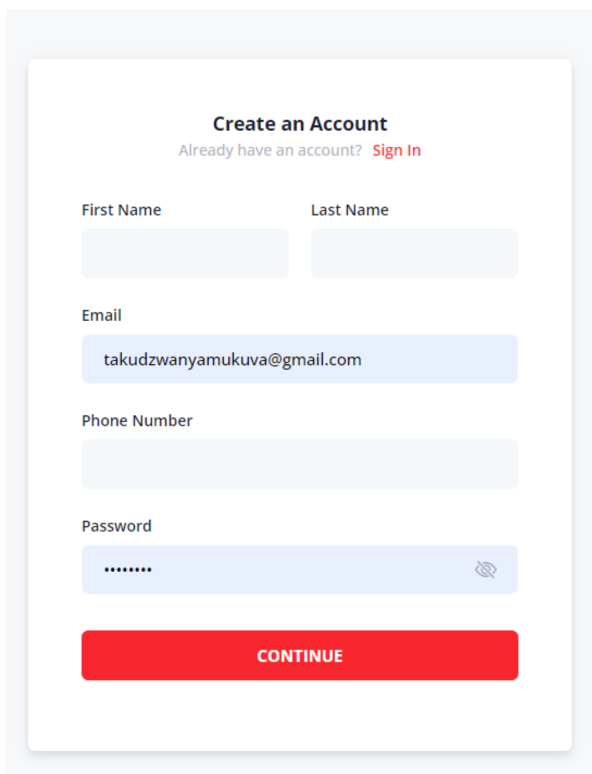

Figure 18: Registration Page

➢ Users can only access system resources once they are logged in.

➢ User is required to login using email and password.

➢ If the user doesn't have an account, they can register on the register page.

2. Dashboard

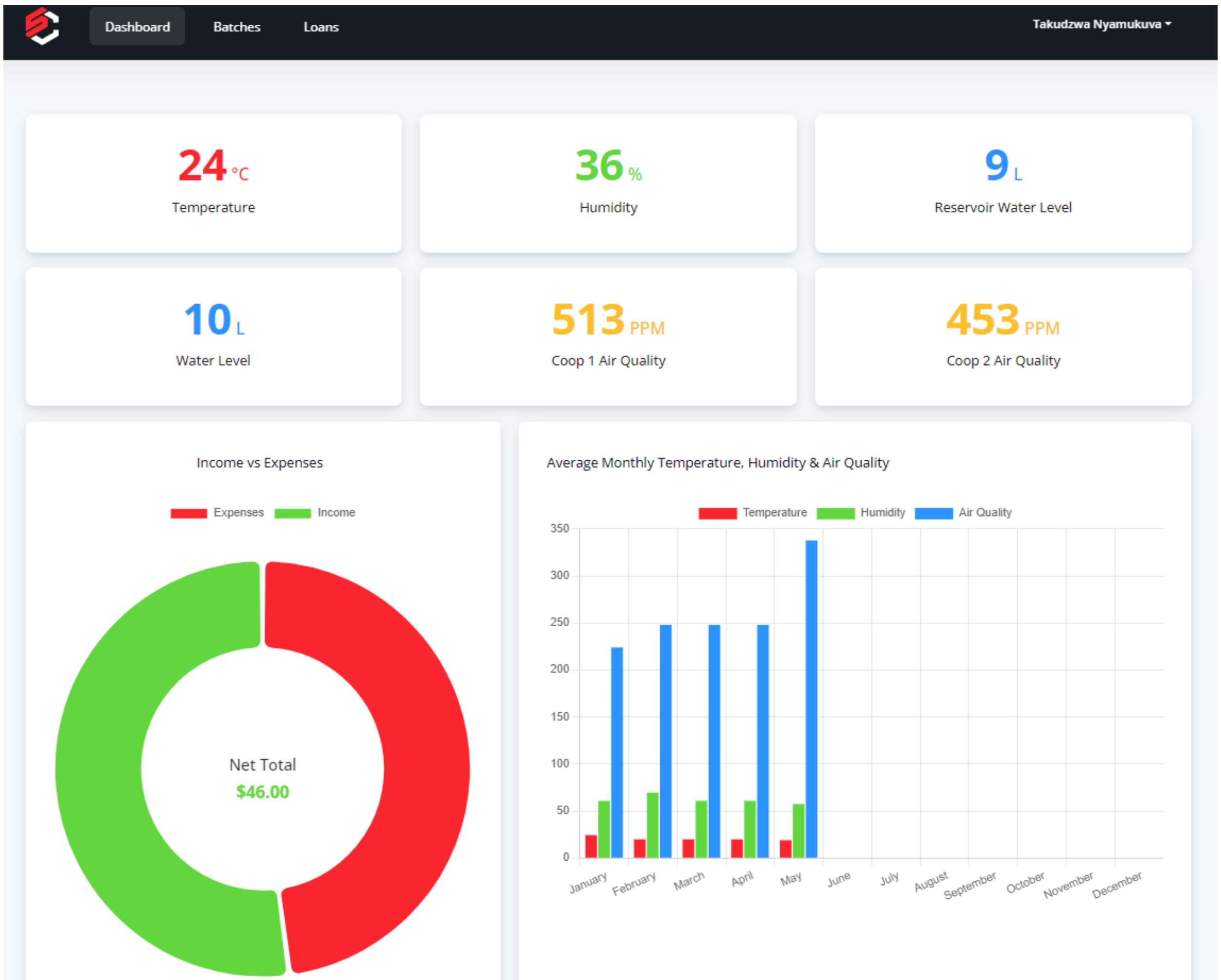

Figure 19: Monitoring Dashboard

➢ The user can view real-time environmental conditions of the chicken coop from this dashboard.

3. Batches Page

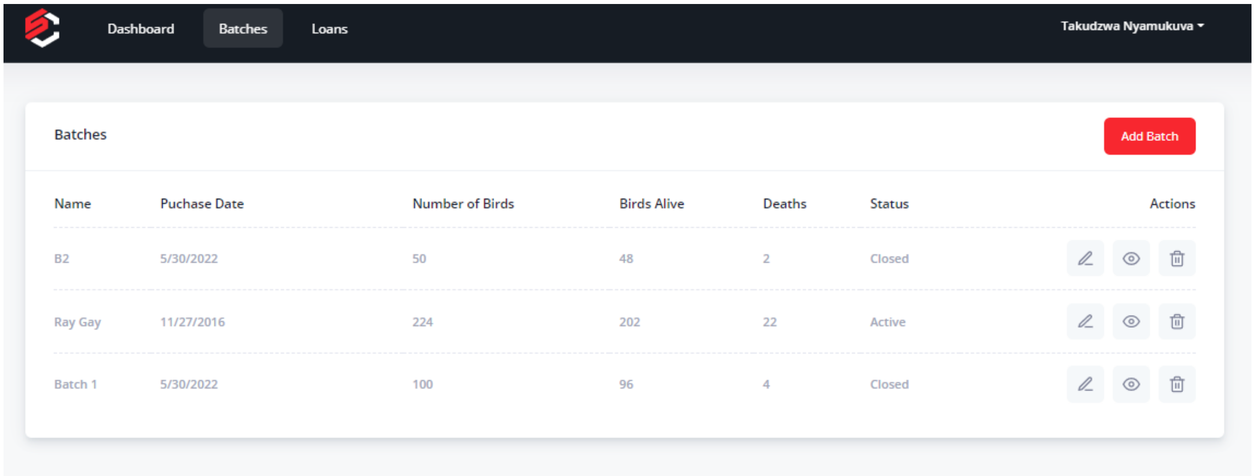

Figure 20:Batches Page

- ➢ This page displays all the batches of chickens created that year.
- ➢ Users can carry operations like create, delete, update and view individual batch information from this page.

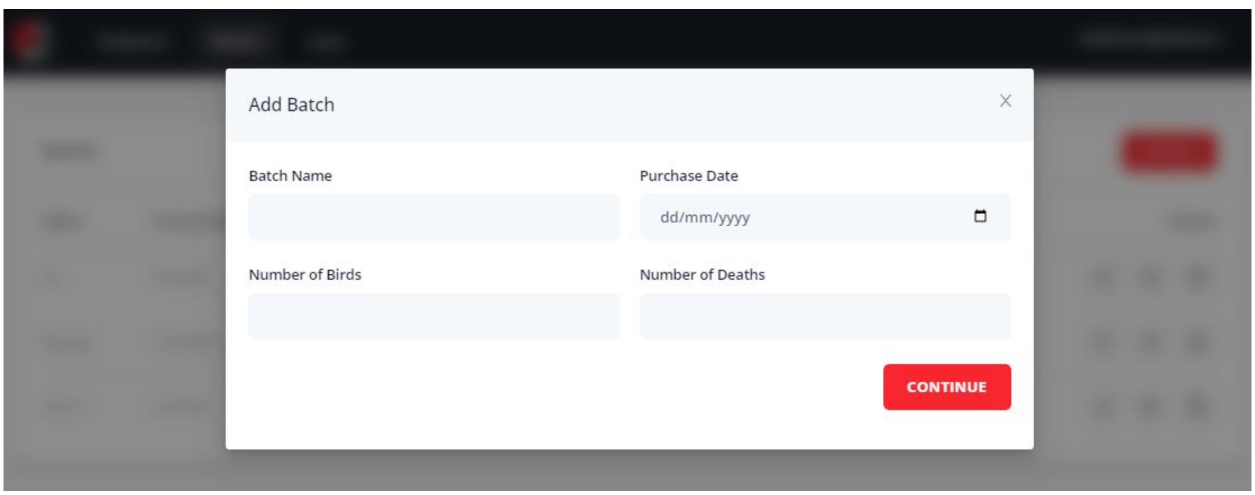

Figure 21: Create Batch

4. Batch Dashboard

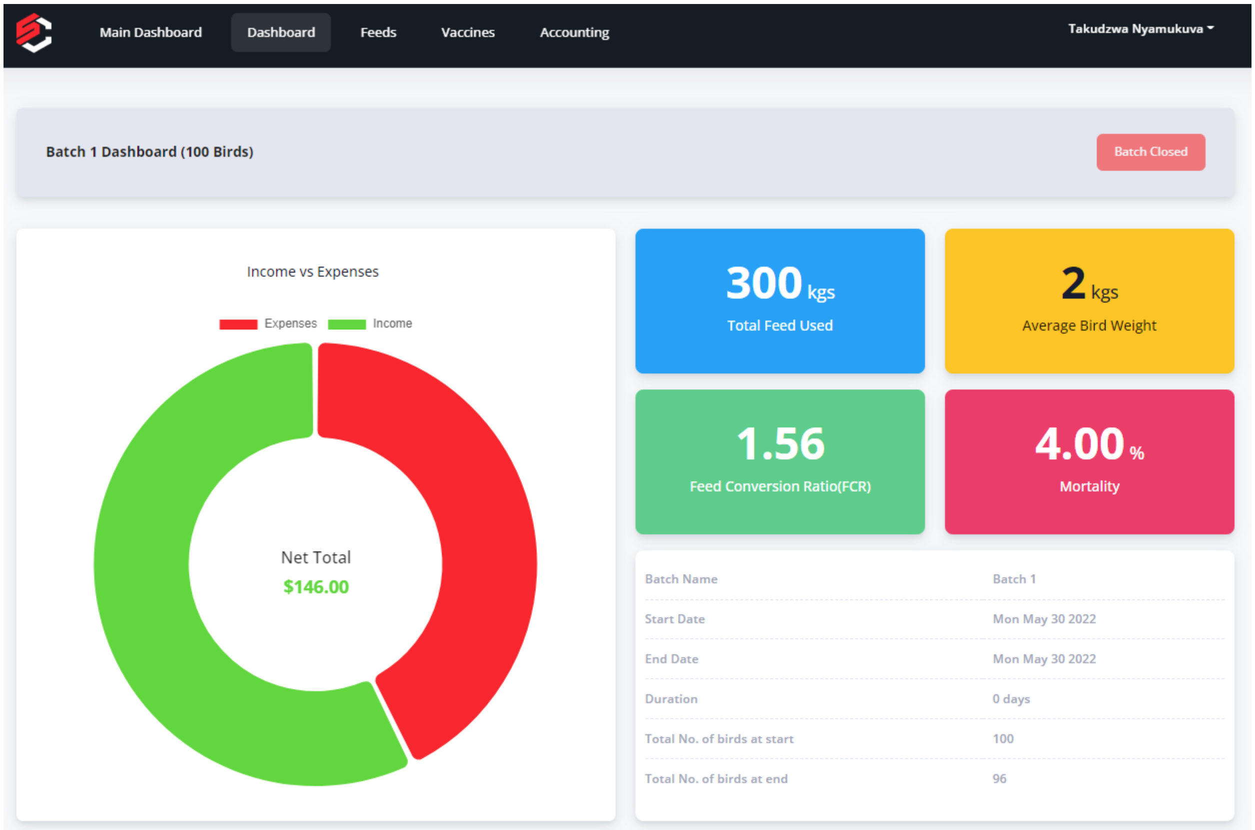

Figure 22:Batch Dashboard

- This is the dashboard for a specific batch of chickens.
- Users can acquire information like total feed used, average bird weight, FCR (Feed conversion ratio), mortality etc. for that particular batch.
- After the batch has run its course, users are edged to press the close batch button.

5. Feeds

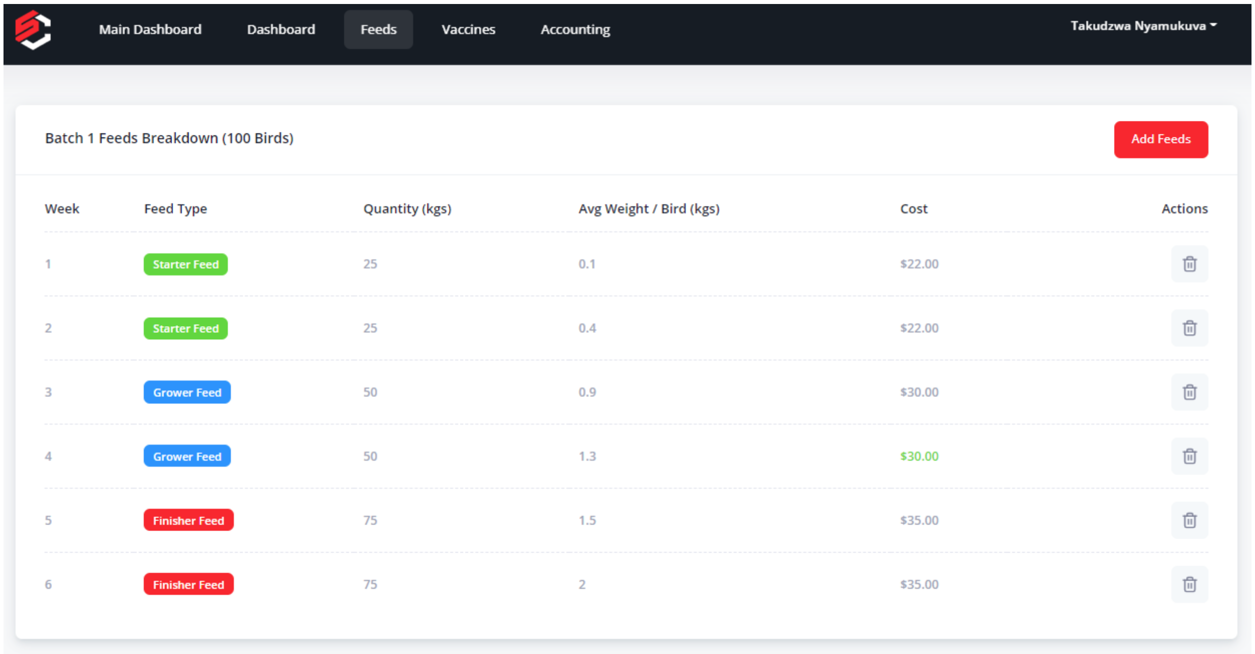

Figure 23:Batch feeds page

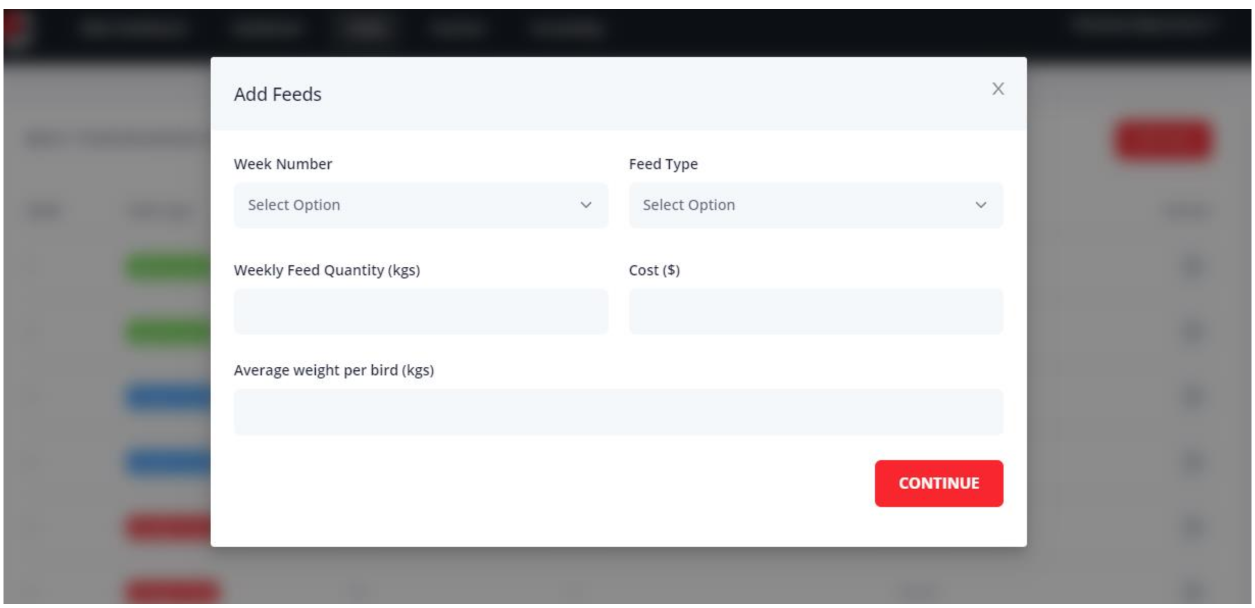

Figure 24: Add feeds

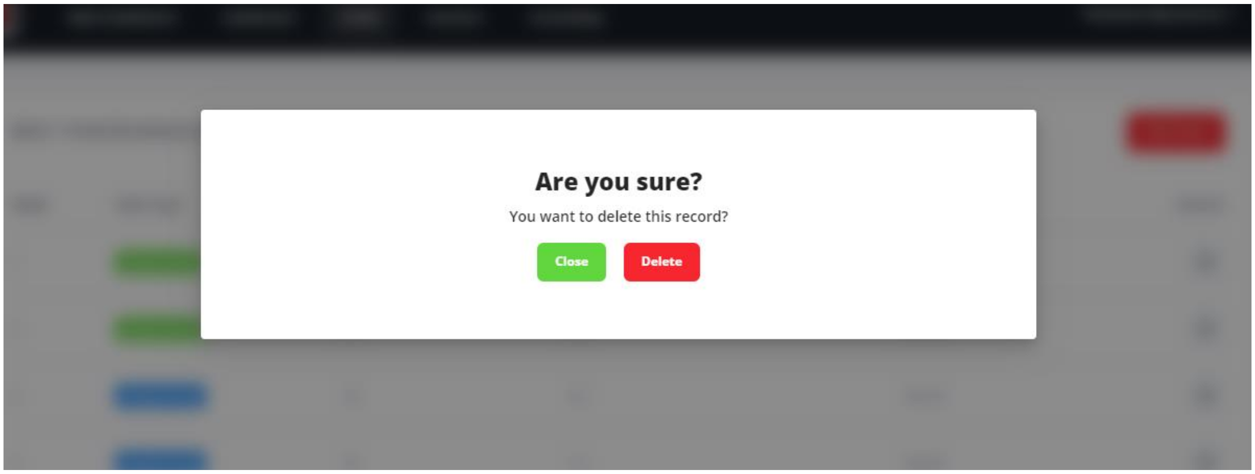

Figure 25: Delete Feed confirmation

➢ The user is prompted to confirm before delete since this action is irreversible.

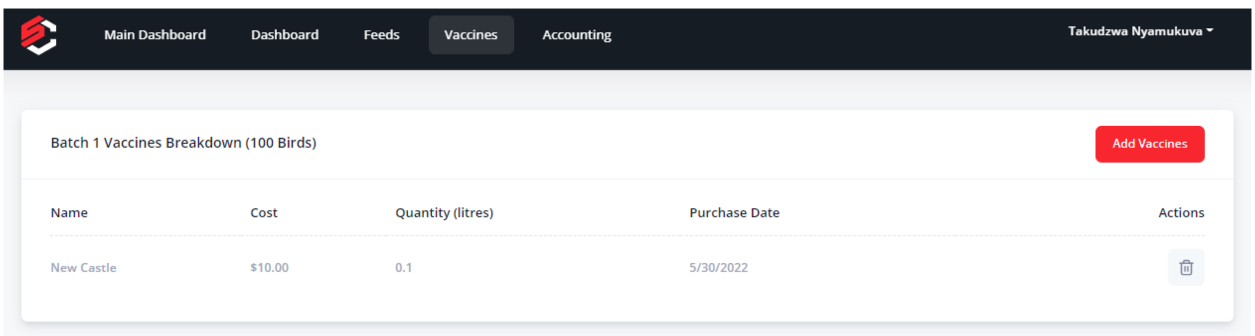

Figure 26:Vaccines Page

➢ This page has the same operations as the feeds page.

6. Accounting

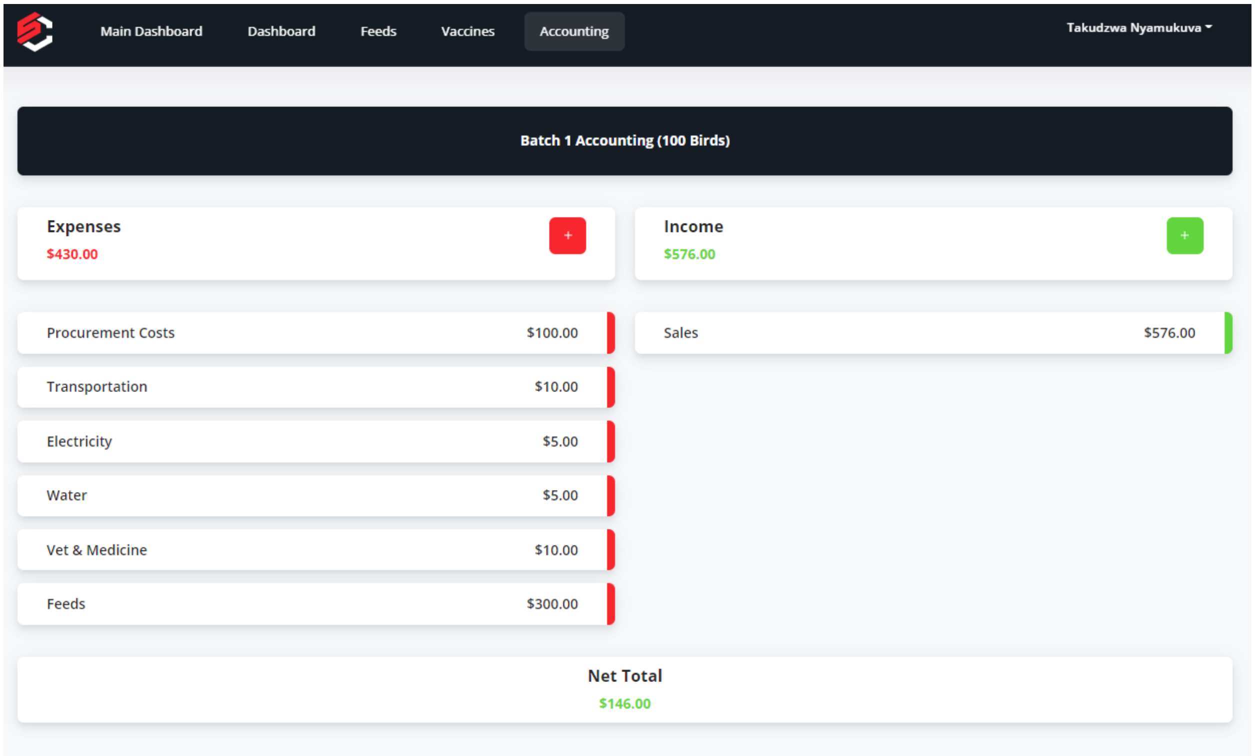

Figure 27:Batch Accounting

➢ This page shows total inflows and outflows and their build up to help the farmer track their financials with ease.

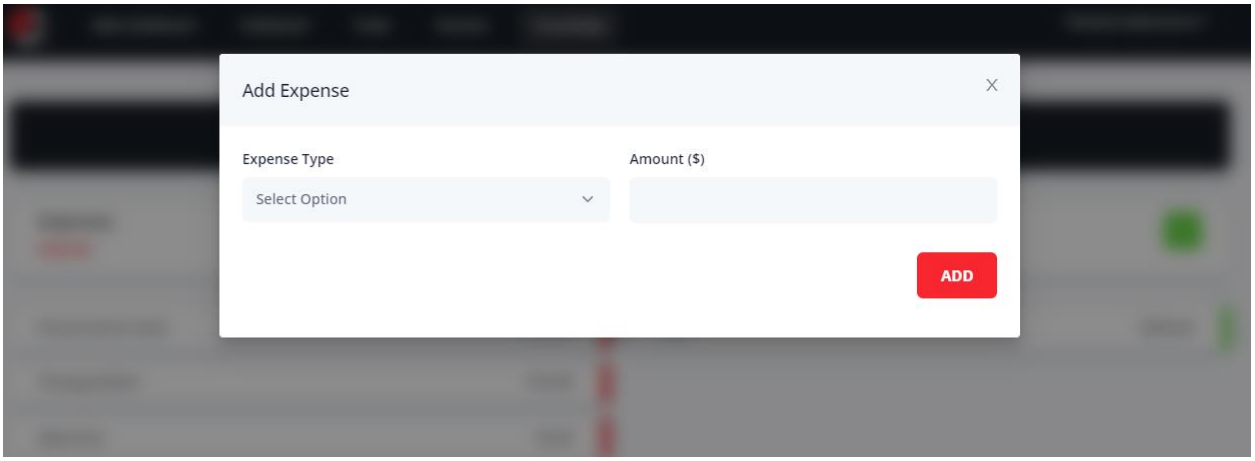

Figure 28:Add Expense

➢ This view is used for adding expenses. The user selects an expense form the dropdown menu.

Appendix C: Survey Paper

SURVEY PAPER ON IoT BASED SMART CHICKEN FARM

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ABSTRACT

The advancement of technology and automation has made everyday living more convenient. This study focuses on the automation of a chicken farm utilizing several sensors, a Bluetooth Module, and the Arduino Uno Micro-controller. Chicken is the most popular produce in today's world since it is a nutrient-dense food with more protein, less fat, and less cholesterol than other poultry. In this study, environmental factors of a chicken farm such as temperature and humidity are monitored and regulated automatically in order to maximize chicken development and product quality. Water level is also adjusted and monitored with the help of ultrasonic sensors. Ammonia and carbon dioxide gasses are monitored using the MQ135 air quality sensor. Using data from the sensors, the person in charge of the chicken farm can obtain information on the farm's internal environmental state by accessing the internet on a PC or a mobile phone. This system will manage temperature, humidity, gasses, and water level without human involvement by using a cooling fan, heater, and a water pump. It will turn on the gadgets based on the threshold values. As a result, this technology automates chicken farming, minimizes labour requirements, and enhances the output of nutritious chicken.

Keywords: Chicken, Automation, Water level, Ammonia.

I. INTRODUCTION

The chicken poultry industry is crucial to Zimbabwe's long-term food security. As a result, there is a greater awareness of the health of chickens as well as the quality of their products. Many issues emerge while caring for chickens since it is a time-consuming and an intricate operation that requires vigilance and the minimization of mistakes. To address these issues, an IoT-based Chicken Farm may be built utilizing a basic micro-controller, such as the Arduino Uno, and a few sensors, such as temperature, humidity, and air quality sensor.

II. LITERATURE REVIEW

Smart Poultry Farm: An Integrated Solution Using WSN and GPRS Based Network

Mahale and Sonavane (2016) propose a model which includes Food and Water Level Control Mechanism for Smart Poultry Farming. They focus on the use of wireless sensors and mobile system networks to remotely monitor and control environmental parameters in poultry farms. The goal is to regulate temperature and humidity levels in the environment. The responsible person can be able to get the information about the internal environment of poultry farm by receiving a message on his mobile number. Water level and food control mechanisms are also designed using sensors in this system. According to Mahale and Sonavane, the quality of the food fed to the chickens affects the quality of the chicken products. To get a detailed view of the chicken farm environment, a webpage is used. This study is a success in terms of temperature control, but it is limited in that it does not automatically supply food or water, relying instead on manual refills.

Smart farm monitoring using Raspberry Pi and Arduino

Jindarat and Wuttidittachotti (2015) propose an Intelligent System that uses Embedded Systems and a Smart Phone to deal with supervision and problem elimination on a poultry farm. The Raspberry Pi and Arduino Uno microcontrollers are used in this research. The system's primary function is to monitor environmental parameters such as humidity, temperature, and climate quality. A filter fan regulates these aspects of the poultry farm's environment. The system is deemed suitable and simple to use by farmers, despite the fact that it does not allow for continuous water supply for better chicken growth.

A hybrid mobile environmental and population density management system for smart poultry farms

So-In C, et al. (2014) focus on using a sensor network and mobile devices to control and monitor environmental parameters in a chicken poultry farm remotely. By sending an SMS to the owner's registered mobile number, this system allows the owner to monitor various environmental related parameters such as temperature, humidity, and so on. The owner can initiate a required action by sending a message back to the system, and if the system does not receive a command within a certain time period, it will automatically initiate the action. As a result of the system's design, an efficient automated and smart poultry farm monitoring system is available. Goud and Sudharson (2015) also propose the use of wireless sensors and a mobile system network to control and monitor the poultry farm remotely. The poultry owner can use his or her mobile phone to receive information about the weather conditions on the farm. To complete an action, the owner can resend the message to the system to finish a failed task. Data from remote sensors is sent to a server and displayed in Google spreadsheets.

Wireless Sensor Networks Applied on Environmental Monitoring in Fowl Farm

Fangwu Dong and Naiqing Zhang proposed the real-time monitoring requirement of poultry farms on the environment, and an online monitoring system based on ZigBee module is designed for poultry farms on the environment. It will provide a network of real-time monitoring system, which includes node controller, data receiver, data transmission, and control node, all of which are TI's CC2430 based on ZigBee interface technology. To detect different environmental parameters, CO2 sensors use TGS4161, while temperature and humidity sensors use SHT75. The data transmission protocols and communication formats of the system were designed after an analysis of the system's data transmission and the simplification of the ZigBee protocol stack.

Design of an Intelligent Poultry Feed and Water Dispensing System Using Fuzzy Logic Control Technique

According to O. M. Olaniyi et al., the low cost of production and high human involvement in poultry farms may result in low profit and return on investment. These flaws in the poor chicken feeding system prompted this work, which involved developing an intelligent fuzzy logic-based system that could mimic the roles of poultry labourers in delivering water and feed food to birds at predetermined time intervals. The designed system senses water and feed levels and dispenses intelligently in response to variations in water and feed levels as the chicken consume the water and feed. This system reduces the workload of poultry attendants, increases cost savings, and generates a good return on investment in the poultry farming system.

PLC Based Poultry Automation System

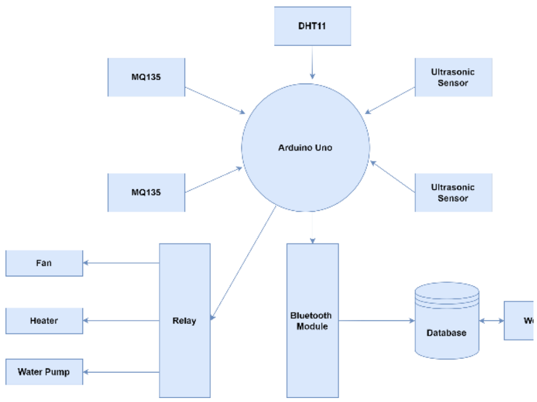
Rupesh I. Muttha, et. al discovered that poultry farming is currently done manually, preventing farmers from reaping the full benefits. A few years ago, feeding whole cereals to chickens as a scratch feed or as part of a complete diet was common practise. With the expansion of large poultry production, automatic feeding systems, which primarily used full-fed complete diets, became the feeding method of choice. One of the major tasks is to control and monitor environmental parameters related to a poultry farm in order to ensure complete chicken care. The goal is accomplished through the use of a sensor-based system. Poultry farming must be environmentally controlled through automation using PLC. These Environmentally Controlled Poultry Sheds are monitored 24 hours a day, seven days a week. It will produce better results while reducing man-hours and human errors.

Wireless sensor network: A complete solution for poultry farming

Ammad-Uddin, et al. (2014) developed a well-thought-out solution for poultry farming. To begin, the authors investigated the control and monitoring of poultry diseases using a wireless sensor network in a modern rooster farm. This wireless network's solutions for poultry farming can establish an ideal farm with maximum productivity and economy. The anticipated solution employs a wearable wireless sensor node, which could be used to detect outbreaks of infected roosters. Furthermore, the wearable sensor nodes, as well as the fixed sensor nodes in the shed and the soil, improve the farm's overall production, quality, and economy.

III. PROPOSED SYSTEM

The Smart Chirugwi is a system that consists of both hardware and software components. Smart Chirugwi is a system that monitors and maintains temperature and humidity in a chicken coop, as well as monitors air quality and automates water delivery to chickens. The system includes a web-based dashboard that displays real-time environmental conditions of a chicken coop. The dashboard also includes a feature for managing chicken batches, such as feeds, vaccines, and accounting (profit and loss) for a specific batch of chickens.



4.3

Figure 1: Solution Architecture

IV. FINDINGS

The ultrasonic sensor's distance measurements were affected by the container's height and diameter. Any obstruction to the ultrasonic sensor may result in inaccurate measurements. Although temperature and humidity are directly proportional, this study demonstrated that temperature can remain constant while humidity rises or vice versa. Gas sensors must be properly calibrated and must be deployed in the real world for at least 48 hours for them to function properly. The obtained results were consistent with theory, indicating that the study is feasible. The developed system is adaptable as it reduces labour and lessens the burdens previously experienced in broiler production.

V. CONCLUSION AND FUTURE WORK

Instead of Bluetooth, a GSM Module or an ESP Module can be used to allow the user to access the data of the chicken coop from anywhere in the world with ease. The Smart Chirugwi can include a security feature for the chicken farm. A security feature can be implemented to ensure that no intruders enter the farm. To eliminate the majority of human errors in broiler production, the Smart Chirugwi can include a feed automation feature.

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Appendix D: Technical Paper

TECHNICAL PAPER ON IoT BASED SMART CHICKEN FARM

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ABSTRACT

The advancement of technology and automation has made everyday living more convenient. This study focuses on the automation of a chicken farm utilizing several sensors, a Bluetooth Module, and the Arduino Uno Micro-controller. Chicken is the most popular produce in today's world since it is a nutrient-dense food with more protein, less fat, and less cholesterol than other poultry. In this study, environmental factors of a chicken farm such as temperature and humidity are monitored and regulated automatically in order to maximize chicken development and product quality. Water level is also adjusted and monitored with the help of ultrasonic sensors. Ammonia and carbon dioxide gasses are monitored using the MQ135 air quality sensor. Using data from the sensors, the person in charge of the chicken farm can obtain information on the farm's internal environmental state by accessing the internet on a PC or a mobile phone. This system will manage temperature, humidity, gasses, and water level without human involvement by using a cooling fan, heater, and a water pump. It will turn on the gadgets based on the threshold values. As a result, this technology automates chicken farming, minimizes labour requirements, and enhances the output of nutritious chicken.

Keywords: Chicken, Automation, Water level, Ammonia.

I. INTRODUCTION

The chicken poultry industry is crucial to Zimbabwe's long-term food security. As a result, there is a greater awareness of the health of chickens as well as the quality of their products. Many issues emerge while caring for chickens since it is a time-consuming and an intricate operation that requires vigilance and the minimization of mistakes. To address these issues, an IoT-based Chicken Farm may be built utilizing a basic micro-controller, such as the Arduino Uno, and a few sensors, such as temperature, humidity, and air quality sensor.

II. PROBLEM STATEMENT

Farmers lose a lot of money due to chicken deaths caused by uncontrolled environmental factors such as temperature, humidity, and gasses i.e., ammonia and carbon dioxide. Controlling the parameters using human labour is inefficient and unreliable. By using an IoT-based chicken farm, farmers may decrease chicken deaths and financial losses.

III. RELATED WORK

Several previous studies on this topic have been conducted. Sneha. M. carried out the preliminary research, which included integrating wireless sensors and mobile networks to regulate and monitor the livestock environment. The DHT22 sensor module was used to detect the humidity and temperature levels in the air. As a result, the serial monitor displayed all temperature and humidity values sensed by the sensor.

Rupali B. Mahale and S. Sonavane [1] conducted the following study, in which they implemented a method to assess the degree of food availability on chicken farms. The user will receive information on the level of foods and water on the farm via the GPRS network, according to the findings of this study.

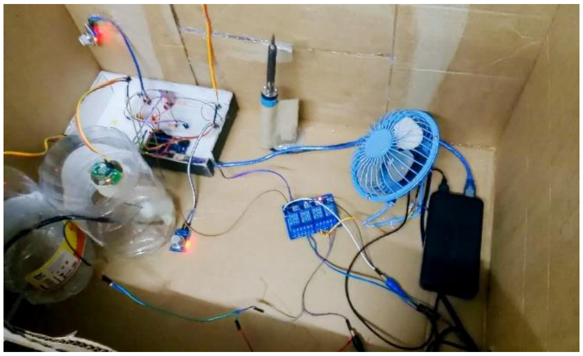
In a separate study, Rupali B. et al. combined the WS (Wireless Sensor Network) and GPRS (General Packet Radio Service) networks to automatically monitor ammonia levels. In this study, the MQ135 sensor is used. The ammonia threshold is 40%, and if the sensor detects this value, the fan will start immediately.

In another study, So-In C, et al. proposes a hybrid mobile environmental and population density management system for smart poultry farms. So-In C, et al. focus on using a sensor network and mobile devices to control and monitor environmental parameters in a chicken poultry farm remotely. By sending an SMS to the owner's registered mobile number, this system allows the owner to monitor various environmental related parameters such as temperature, humidity, and so on. The owner can initiate a required action by sending a message back to the system, and if the system does not receive a command within a certain time period, it will automatically initiate the action.

IV. SOLUTION

The challenges described in the problem statement were solved by a solution with the following objectives.

- monitoring and maintaining temperature and humidity in a chicken coop.
- monitoring the quality of air in the chicken coop.
- automating the provision of water to the broilers.
- a dashboard for chicken batch management.



A. *Solution Architecture*

The Smart Chirugwi is a system that consists of both hardware and software components. Smart Chirugwi is a system that monitors and maintains temperature and humidity in a chicken coop, as well as monitors air quality and automates water delivery to chickens. The system includes a web-based dashboard that displays real-time environmental conditions of a chicken coop. The dashboard also includes a feature for managing chicken batches, such as feeds, vaccines, and accounting (profit and loss) for a specific batch of chickens.

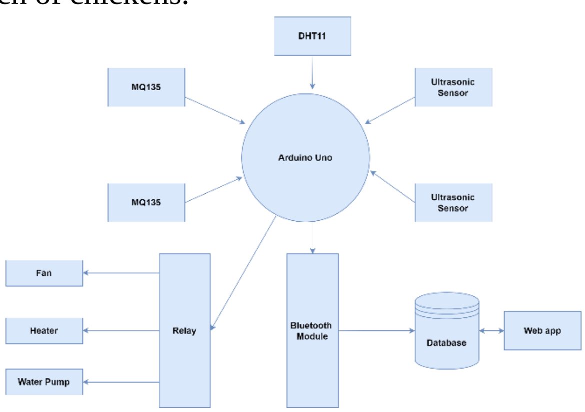


Figure 1: Solution Architecture

B. *Coding strategy*

The coding strategy is a set of steps taken to complete all of the project's objectives. Because of the large size of this project, it was divided into modules. Before creating the database collections, a clear plan of how it would be structured was created. Before creating the classes, the structure and relationships between them were defined. Some of the features were created through trial and error until the desired results were obtained. The hardware part of the system was implemented using a pseudo code that guided all coding activities.

C. *Experimentation and Testing*

Test Case	**Expected Results**	**Status**
User registration	User created account successfully.	Success
Fan turns on when temperature is high	Fan turns on until temperature is normal.	success
Fan turns on when humidity is high	Fan turns on until humidity is in normal range i.e., 50 – 70%	success
Water pump turns on the refill water when the level is low	Water pump turns on until a certain threshold is reached.	success

VI. CONCLUSION

This chapter analysed the overall system performance results and identified areas for improvement, stating which factors needed to be considered. It also considered the scope of future work and the technologies that could be used to make the Smart Chirugwi a one-stop solution for chicken farm automation

VII. FUTURE WORK

While all of the project's objectives were met, a few areas for improvement that would make the project more efficient and dependable were found. These are some examples:

- Instead of Bluetooth, a GSM Module or an ESP Module can be used to allow the user to access the data of the chicken coop from anywhere in the world with ease.
- The Smart Chirugwi can include a security feature for the chicken farm.
- A security feature can be implemented to ensure that no intruders enter the farm.
- To eliminate the majority of human errors in broiler production, the Smart Chirugwi can include a feed automation feature.

VIII. BIBLIOGRAPHY

Takudzwa Pride Nyamukuva is a student studying Computer Science at Harare Institute of Technology.

Fadaraliki David Innocent holds an MTech in Cloud Computing from SRM University (Chennai, India) and a BTech (hons) degree in Computer Science from Harare Institute of Technology. He is also is a lecturer at Harare Institute of Technology.

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