

PROJECT SWINESCAN: IOT TECHNOLOGY SCANNER FOR COMMON SYMPTOMS OF AFRICAN SWINE FEVER

Winston G Domingo^{1*}, Carmela G Blando², and Dennie T Ruma³

¹College of Teachers Education, Quirino State University-Maddela Campus, Maddela, Quirino, Philippines.

^{2,3}College of Agriculture, Quirino State University-Maddela Campus, Maddela, Quirino, Philippines.

¹<http://orcid.org/0000-0003-2516-7491>, ²<http://orcid.org/0000-0001-6848-7159>, ³<http://orcid.org/0009-0005-2785-2830>

E-mail: *winston.domingo@qsu.edu.ph, carmela.blando@qsu.edu.ph, dennie.ruma@qsu.edu.ph

ARTICLE INFO

Article History

Received on: December 12, 2025

Reviewed on: January 12, 2026

Accepted on: April 10, 2026

Published on: June 30, 2026

Keywords:

African Swine Fever.

Decision-Support System.

GIS.

IoT.

Swine.

ABSTRACT

African Swine Fever (ASF) continues to pose a serious threat to swine farmers, resulting in significant economic losses and livelihood challenges. Traditional methods of ASF detection often rely on physical inspections and laboratory testing, which are time-consuming and prone to delays in results. This study developed Project SwineScan: IoT Technology Scanner for Common Symptoms of African Swine Fever, integrating sensor technology, stored data management, and GIS-enabled analytics to provide a real-time and automated monitoring solution. The system utilizes non-invasive sensors that measure the vitals of the swine, including body temperature, heart rate, and oxygen saturation. Data was collected and transmitted to a web platform using an API for data visualization, analysis, and reporting. GIS mapping supported spatial visualization, enhancing decision-making for targeted interventions. Evaluation of the system demonstrated its capacity to provide timely, accurate, and actionable information to farmers, veterinarians, and local government units. By functioning as both a monitoring and decision-support tool, Project SwineScan offers a sustainable approach to ASF control while strengthening resilience within the swine and agricultural sectors.



Copyright ©2026 by authors and Galileo Institute of Technology and Education of the Amazon (ITEGAM). This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

1. INTRODUCTION

African swine fever (ASF) is caused by the African swine fever virus (ASFV), a member of the Asfarviridae family. It is the only DNA virus transmitted by arthropods. It is highly contagious, resulting in up to 100% morbidity in previously unexposed pig herds with mortality varying between 0 and 100% depending on the virus, the host, the dose, and the route of exposure to the virus [1]. African swine fever is a large, icosahedral, linear double-stranded DNA virus and the only member of the family Asfarviridae, genus Asfivirus. African swine fever virus (ASFV) is maintained in Africa via a complex transmission cycle involving African wild suid species, soft ticks, and domestic pigs [2]. Animal diseases constitute a continuing threat to animal health, food safety, the national economy, and the environment. Among those, African swine fever (ASF) is one of the most devastating viruses affecting pigs and wild suids due to the lack of a vaccine or effective treatment [3].

Pigs provide an important source of high-quality protein, and production is predicted to increase in the future to meet growing global demands for meat. However, the pork supply is threatened by infectious diseases, and amongst these, African swine fever (ASF) is currently causing the greatest concern [4]. ASF remains a significant concern for the Philippines, impacting the swine industry and food security. It causes high mortality rates, leading to decreased pork production, high prices of pork and pork products, and financial losses for farmers and stakeholders, especially for the livelihoods of many small-scale pig farmers in the Philippines [5]. Emergence of African swine fever (ASF) in the Philippines in 2019 caused substantial impacts on animal health and its pig industry. To control ASF, strict policies were applied, including zoning and depopulation of infected herds. Risk estimation of ASF transmission must consider meat sample contamination [6]. Surveillance at local borders can monitor contamination and prevent ASFv sources from entering areas. This approach allows the government to allocate resources and prioritize higher-risk areas [7].

At present, there is no safe and effective vaccine for African swine fever, and the most effective way to combat it is to establish stringent and safe biological prevention and control measures [8]. One of the key observations of this disease is the presence of a high fever [9]. This severe viral disease is characterized by respiratory and digestive dysfunction, congestive bleeding [10], a fever exceeding 41 °C, and symptoms such as loss of appetite and lethargy [11]. Real-time temperature monitoring systems have emerged as essential tools for early ASF diagnosis [12]. ASF is a highly infectious and fatal viral disease that affects both domestic and wild pigs. Its rapid spread via both direct and indirect pathways poses a substantial and ongoing threat to pig populations around the world. An ASF outbreak can have devastating consequences, resulting in high mortality rates and significant economic losses for farmers and the pig sector. Current diagnostic approaches, which frequently include time-consuming laboratory testing, can exacerbate the delay in important outbreak-control treatments. Developing novel technologies like "Project SwineScan: IoT Technology Scanner for Common Symptoms of African Swine Fever" provides a viable solution to these issues. By facilitating the early detection of ASF symptoms through contactless monitoring, this device seeks to offer a substantial benefit.

Project SwineScan has several important advantages that resolve the most pressing challenges in treating African Swine Fever. First of all, by detecting early symptoms of disease, its ongoing monitoring capabilities allow for the early identification and prompt isolation of potentially contaminated animals. This quick action is required to avoid the ASF virus from spreading widely throughout a herd. Second, the availability of real-time health data facilitates improved biosecurity measures by enabling prompt action in the event of a suspected infection. This proactive strategy greatly reduces the possibility of economic losses and helps to manage outbreaks at their source. Furthermore, Project SwineScan helps to enhance disease surveillance by gathering important information on pig health and illness patterns. The development of more focused and effective intervention plans can be aided by using this data to pinpoint high-risk locations and track how well control measures are working. Further, the data can offer significant insights into the complex nature of ASF transmission and other environmental factors that impact its dissemination. In the long run, Project SwineScan is essential to assisting pig farmers and the pork sector by giving them a proactive tool for managing the health of their herds. Considering the catastrophic impact of ASF on the supply of food worldwide, this can assist in minimizing losses, stabilizing production levels, and enhancing the pork industry's general resilience and sustainability.

The integration of available medical sensors creates a connected digital platform that empowers the connectivity with pets and livestock with improved efficiency. These kinds of technologies make a precise health status and sickness projection, which are most effective in humans, but they can be applied to animals with few changes [13]. IoT was conceptualized to improve human and pet interaction by medical or health opportunities, through information retrieval [14]. A prototype of a smart animal health monitoring system based on IoT for real-time monitoring of the physiological parameters, such as body temperature, heart rate, and rumination, with surrounding temperature and humidity has been developed [15]. Project SwineScan: IoT Technology Scanner for Common Symptoms of African Swine Fever aims to be contactless, potentially using a non-invasive sensor technology like radar or infrared to monitor pigs without physical contact. This is a significant innovation compared to existing livestock monitoring systems that often rely on physical attachments. Incorporating an AI algorithm specifically trained to detect ASF-related symptoms based on the unique physiological changes associated with the disease. A wearable design that allows for continuous monitoring of individual pigs, potentially providing more accurate and timely detection of ASF symptoms compared to traditional methods.

1.1 SPECIFIC OBJECTIVES

- To develop an Internet of Things (IoT)-based prototype device that can detect common symptoms of African Swine Fever (ASF).
- To develop an information system that provides data analytics for ASF, with the integration of the Graphical Information System (GIS).

II. THEORETICAL REFERENCE

II.1 THE THREAT OF AFRICAN SWINE FEVER (ASF)

African swine fever (ASF) is a viral hemorrhagic disease characterized by exceptionally high lethality in domestic pigs and Eurasian wild boar [16]. Originating in Africa, the disease has since spread to Europe, Asia, and Oceania, reaching a pandemic dimension since 2007, posing a global threat to the swine industry [17]. Given the absence of effective ASF vaccines, disease management options are limited, making the identification and minimization of ASF-associated risk factors critical to preventing outbreaks [18]. This absence of available vaccines renders biosecurity measures, cleaning, and disinfection procedures essential control tools for the prevention of primary and secondary introductions of ASF in pig farms [19].

II.2 THE NECESSITY FOR EARLY, RAPID DETECTION

The immediate and accurate detection of highly contagious diseases like ASF is the single most critical factor in mitigating significant economic losses for pig producers and governments. Traditional detection methods, which rely on clinical observation and periodic laboratory testing, are often time-consuming and lead to critical delays in containment. The most common initial clinical indicators of infection—such as fever (increased body temperature) and reduced motion—often precede or occur simultaneously with decreases in feed/water intake and even the definitive detection of the virus via molecular methods [20].

II.3 LIMITATIONS OF DEFINITIVE LABORATORY DIAGNOSTICS

While highly sensitive and specific real-time PCR (qPCR) assays are the scientific "gold standard" for definitive confirmation by detecting viral DNA, they require sample collection, transport, and laboratory processing, creating a time lag [21]. Studies have shown that the physical symptoms detected by a real-time monitoring system can signal infection before a positive qPCR result is obtained. This establishes the role of continuous, real-time monitoring systems, such as Project SwineScan, as a crucial pre-screening mechanism to bridge the gap between initial infection and definitive laboratory confirmation [22].

II.4 INTEGRATION AND DECISION-SUPPORT SYSTEMS (IOT, AI, AND GIS)

The Internet of Things (IoT) is a system of wireless, interrelated, and connected digital devices that can collect, send, and store data over a network without requiring human-to-human or human-to-computer interaction [23]. The integration of multiple data sources (temperature, HR, movement) within an IoT framework, combined with AI and data fusion techniques, compensates for the limitations of any single method, providing a more robust and comprehensive system for health surveillance [24]. The successful application of such smart online systems in experimental ASF trials confirms their efficacy in automatically alerting staff based on combined vital sign deviations, thereby significantly reducing the time and cost associated with disease control [25]. With the integration of GIS (Geographic Information System), the system can be used to analyze and manipulate the spatially referenced data [26], transforming the real-time health data into actionable spatial insights for targeted intervention.

III. MATERIALS AND METHODS

This chapter discusses the methodology employed in the design, development, and evaluation of the proposed Project SwineScan: IoT Technology Scanner for Common Symptoms of African Swine Fever. The methodology outlines the research design, system development model, and stages of System testing.

III.1 RESEARCH DESIGN

The study utilized a Research and Development (RnD) Design, which focuses on the systematic design, creation, and assessment of a technological solution to a practical problem. In this study, the problem addressed is an efficient and real-time monitoring system for detecting physiological indicators associated with ASF (African Swine Fever) in livestock. The research design emphasizes both the design and development of the system, as well as the testing and evaluation of its performance.

III.2 DEVELOPMENT MODEL

The system was developed using the Rapid Application Development (RAD) Model, which emphasizes iterative prototyping and user feedback. The model consists of four major phases:

Figure 1. The system development process adopted the Rapid Application Development (RAD) Model. RAD is appropriate for projects that need flexibility and user involvement because it places an emphasis on iterative prototyping, user feedback, and rapid development cycles. Rapid Application Development (RAD) is used to develop applications, and blackbox testing is used to test the applications' functionality and usability to see how users react to the final product [27] [28]. Within RAD, a prototyping model was also used. To see the features and user interfaces of the suggested system, early prototypes were made. Actual system development, which includes cloud integration, software coding, and hardware assembly. System deployment, testing, and finalization in a controlled setting.

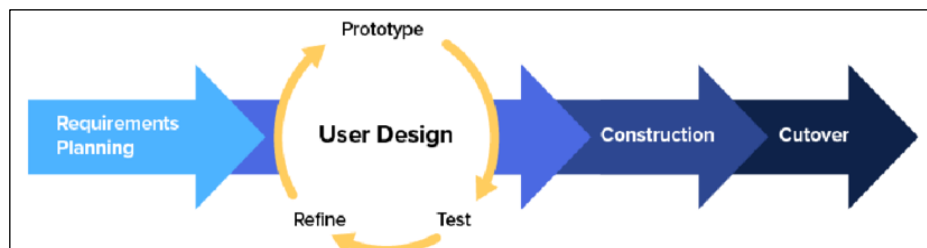


Figure 1: Rapid Application Development Model.
Source: [28].

III.3 SYSTEM DEVELOPMENT PROCEDURE

The development of the Project SwineScan: IoT Technology Scanner for Common Symptoms of African Swine Fever followed a structured procedure consisting of the following stages.

II.3.1 System Requirement Analysis

Identification of the necessary hardware components (sensors, microcontroller, power supply) and software requirements (database, mobile application framework).

II.3.2 Hardware Requirements and Software Requirements

The development of the IoT Device to detect common ASF symptoms required integrating several hardware components to ensure accurate sensing, data acquisition, and wireless transmission. The hardware and software requirements are summarized in Table 1. The summary of System Requirements illustrates the combination of hardware and software components that enabled the development of the ASF Monitoring System. The hardware requirements provided the physical foundation for sensing, processing, and transmitting animal health data. Together, these hardware and software requirements formed a cohesive system architecture that allowed for accurate sensing, reliable data management, and accessible monitoring for end-users. Solid requirements engineering has increasingly been recognized as the key to delivering software and systems projects on time, on budget, and with improved quality. New software tools are emerging that are empowering practicing engineers to improve their requirements engineering habits [29].

Table 1: Summary of System Requirements.

Category	Requirement Specification	Description
Hardware	Heart Rate & Pulse Sensor	Monitors animal pulse and oxygen levels
	Temperature Sensor	Measures animal body temperature contactless
	ESP32 Development Board	Microcontroller for data processing and wireless transmission
	Power Supply Module	Provides stable 5V power to components
	USB Cable	Facilitates programming and power connection
	Electrolytic Capacitor	Stabilizes the voltage supply
	AMS1117-3.3V Regulator	Converts voltage to 3.3V
	Prototype Board	Circuit prototyping platform
Software	PHP	Backend programming for system logic and transactions
	HTML & CSS	User interface development
	MySQL Database	Stores and manages sensor data securely
	Arduino IDE	Programming environment for ESP32
	GIS System	Enhance spatial analysis and visualization of real-time monitoring data using GIS

Source: Authors, (2026).

III.4 SYSTEM DESIGN AND ARCHITECTURE

Figure 2 shows the block diagram for the suggested ASF Monitoring System. The sensor module, microcontroller unit, power supply, cloud infrastructure, and user interface are the system's five main parts. These sensors are in charge of gathering the essential data required to track the health of the animals. The microcontroller, the system's central processing unit, receives the data gathered from the sensors. Internet of Things in Animal Healthcare (IoTAH) uses biosensors and software for monitoring and maintaining animal health records. The Internet of Things enables devices to connect to the Internet and communicate with each other. Data from these IoT-connected devices will help to identify the scenario and take necessary action [30].

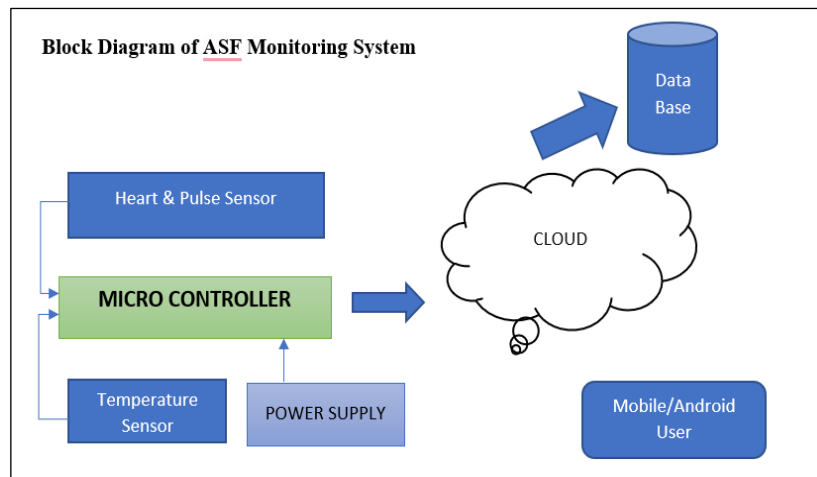


Figure 2: Block Diagram of ASF Monitoring System.

Source: Authors, (2026).

III.5 SYSTEM DEVELOPMENT AND SYSTEM INTEGRATION

The interface's user-friendly presentation of real-time information enables prompt decision-making and intervention. A single functional system was created by integrating the sensors, microcontroller, database, and user interface. End users, including farmers and veterinarians, were able to access real-time animal health data because the user interface was connected to the backend system. System validation was another step in the integration process, where modules were tested collectively to evaluate accuracy, dependability, and usability in actual operating environments. System integration was critical in verifying whether modules developed independently can work cohesively. In this study, careful integration reduced the likelihood of incompatibility issues and enhanced the robustness of the monitoring system [31].

III.6 SYSTEM TESTING AND EVALUATION

Testing the mobile application's usability, data transmission dependability, and sensor accuracy. System responsiveness, accuracy, dependability, and user satisfaction were among the evaluation metrics. The system was put through continuous operation for a predetermined amount of time to test its reliability. The system's ability to reliably capture and transmit precise data without any disruptions was observed. The main role of software testing is to help developers better understand the needs of users and help users better express their needs. In addition, software testing can also predict and avoid some possible problems, but can also help determine the functionality performance standards of the software [32].

IV. RESULTS AND DISCUSSIONS

IV.1 A PROTOTYPE OF AN INTERNET OF THINGS (IOT) TECHNOLOGY SCANNER FOR COMMON SYMPTOMS OF AFRICAN SWINE FEVER

Figure 3. Flow and Process flow illustrate the operational flow of the Project SwineScan system for detecting possible ASF symptoms. The process starts with system initialization, followed by sensor data collection and transmission via API. Data were received on the mobile application and evaluated against normal vital sign ranges for swine. If abnormal readings are detected, the system records the event in the database, links with location data for contact tracing, and displays the findings on the monitoring interface using GIS.

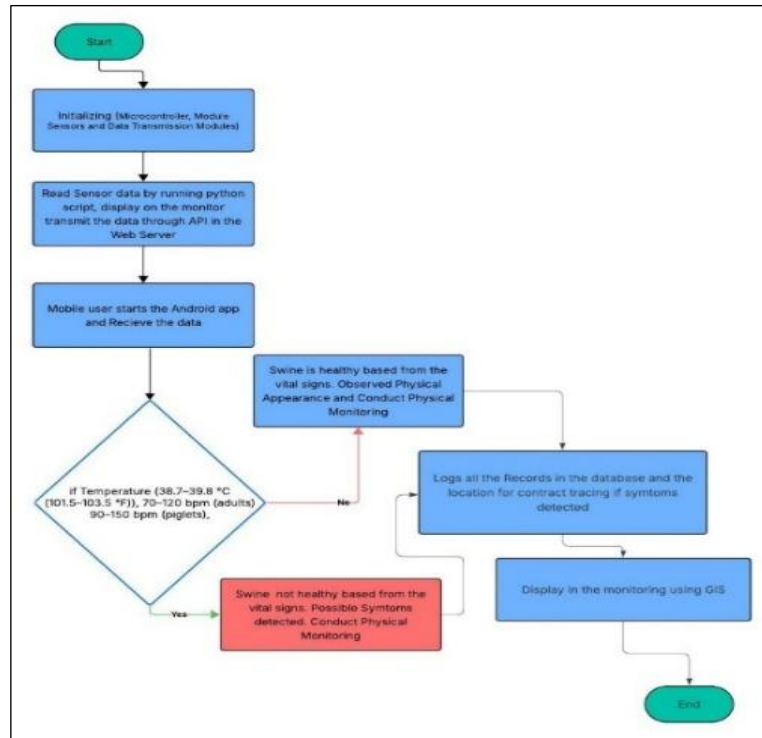


Figure 3: Flowchart and Process Flow.

Source: Authors, (2026).

Table 2 Normal Vital Signs of Swine and Abnormal Indications of Possible African Swine Fever (ASF) presents the normal ranges of swine vital signs and their deviations that may indicate African Swine Fever (ASF). Elevated body temperature, abnormal heart and respiratory rates, as well as changes in skin coloration, feeding behavior, and sudden unexplained mortality are critical markers for early ASF detection and monitoring [33], [34]. These values can vary slightly depending on the age, breed, and health status of the pig. Always consult a veterinarian for specific health assessments. In addition, physiological parameters such as hemoglobin oxygen saturation and end tidal carbon dioxide levels can also provide valuable insights into the health of swine [35].

Table 2: A Basis for Normal Vital Signs of Swine and Abnormal Indications of Possible (ASF).

Vital Sign	Normal Range	Possible ASF Symptom (Abnormal Range)	Indication
Body Temperature	38.7–39.8 °C (101.5–103.5 °F)	>40 °C (104 °F and above)	High fever, one of the primary symptoms of ASF
Heart / Pulse Rate	70–120 bpm (adults) 90–150 bpm (piglets)	Elevated (>130–150 bpm)	Stress response, fever, or infection
Respiratory Rate	25–40 breaths per minute	Rapid or labored breathing (>50 bpm)	Respiratory distress associated with ASF

Source: [33–35].

IV.2 COMPARISON WITH EXISTING TECHNOLOGIES AND RESEARCH CONTRIBUTION

The development of the Project SwineScan system was highly significant because it addresses critical limitations inherent in existing African Swine Fever (ASF) detection technologies across three distinct categories. While laboratory diagnostics, such as real-time Polymerase Chain Reaction (qPCR) and Enzyme-Linked Immunosorbent Assay (ELISA), are considered the gold standard for high-specificity virus identification, they are inherently time-consuming and require specialized facilities, which severely delays outbreak response time [36]. Similarly, rapid field diagnostics, including Lateral Flow Assays (LFA), offer quick results but rely on invasive, single-point biological sampling that is labor-intensive and potentially stressful for the swine herd, often yielding variable performance in the early phase of infection [37]. Project SwineScan surpasses these limitations by functioning as a real-time, non-invasive, pen-side pre-diagnostic system, enabling continuous, 24/7 remote surveillance that detects subtle physiological symptoms (fever, cardiovascular changes) before the need for a definitive viral diagnosis [38], [39].

Furthermore, Project SwineScan demonstrates a key advancement over existing IoT and vision-based monitoring systems, which often rely on single metrics like movement deceleration or require contact-based sensors (e.g., ear-tags) that are prone to loss or detachment [40]. By employing contactless, multiparameter sensing to simultaneously monitor body temperature, heart rate, and oxygen saturation, Project SwineScan provides a more stable and higher-confidence indicator of systemic sickness—a complex state that cannot be reliably captured by relying solely on behavioral proxies or single vitals [41].

IV.3 DEVELOPED TECHNOLOGY DEVICE INTERFACE

Figure 4. Schematic Circuit Block Diagram illustrates the interaction of the major components in the monitoring system: the sensors, the ADC module, the microcontroller, and the display unit. The Heart Rate and Pulse Sensor and the Temperature Sensor serve as the primary input devices, capturing the user's physiological data in analog form. The microcontroller functions as the central processing unit. It receives sensor data, performs necessary filtering and computation—such as heart rate detection and temperature conversion—and controls system operation. After processing, the microcontroller sends the computed results to the LCD Display, which presents real-time heart rate and temperature readings to the user. the block diagram shows a streamlined flow from data acquisition, conversion, and processing, to output display, enabling continuous and accurate monitoring of vital signs.

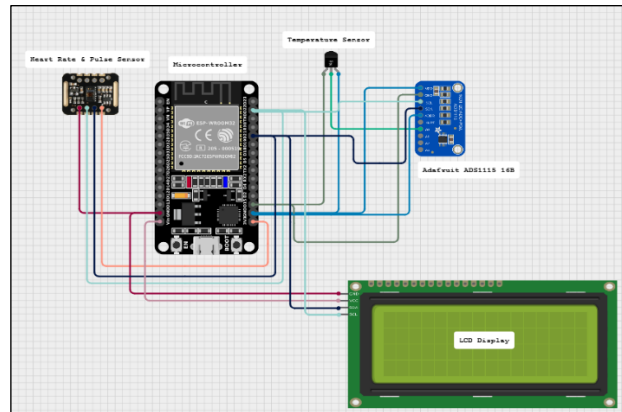


Figure 4: Schematic Circuit Block Diagram.
Source: Authors, (2026).

Figure 5 Prototype of the developed IoT Device. The device was built on a pierced prototyping board and integrates multiple modules. The ESP32 microcontroller for data processing and wireless transmission, the MAX30102 heart rate and pulse sensor, and the MLX90614 contactless temperature sensor. The LCD module provides a real-time output of swine vital signs. This configuration enables the contactless monitoring of swine health parameters as part of the African Swine Fever (ASF) early detection system.

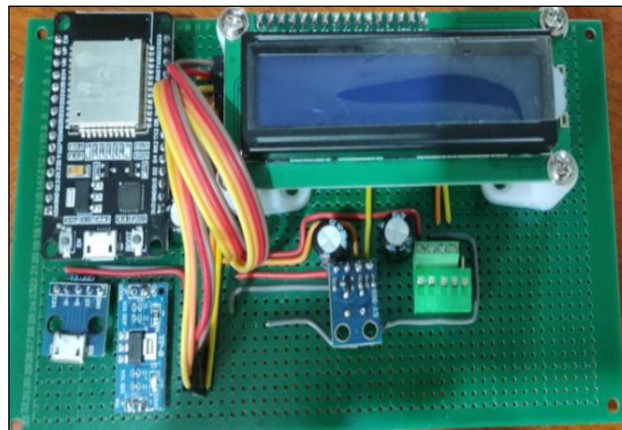


Figure 5: Prototype of the developed IoT Device.
Source: Authors, (2026).

Figure 6 Working Prototype of the developed IoT Device. Functional and working prototype of the Project SwineScan IoT Device system displaying real-time swine vital signs. The LCD screen displays vital parameters: heart rate (HR), body temperature (T), and blood oxygen saturation (SpO₂). The integration of hardware components enables contactless monitoring, while the microcontroller processes and transmits the data to the cloud for storage, analysis, and visualization in the monitoring system. IoT-enabled learning frameworks were using the data science paradigm for providing information on the current health status and real-time monitoring capability of the individual animal in smart livestock [42]. The Internet of Things (IoT) is an emerging paradigm that is transforming real-world things (objects) into smarter devices. IoT applies to a variety of application domains, including healthcare, smart grid, and agriculture [43]. The used of sensors that record animal activity in intensive livestock systems has become more and more frequent for both early detection of diseases and improving production quality. Their application may also be significant in extensive livestock systems, with infrequent farmer-to-animal contact [44].

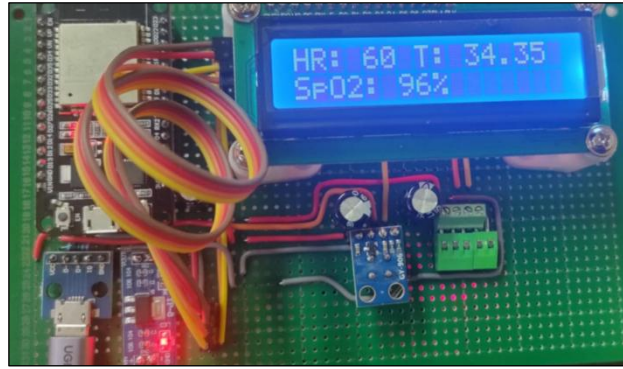


Figure 6: Working Prototype of the developed IoT Device.
Source: Authors, (2026).

IV.4 DEVELOPED AN INFORMATION SYSTEM THAT PROVIDES DATA ANALYTICS FOR ASF, WITH THE INTEGRATION OF THE GRAPHICAL INFORMATION SYSTEM (GIS) DEVICE INTERFACE

Figure 7 Statistical Report for Positive with Symptoms per Barangay and a Statistical Report for Positive and Confirmed with ASF Per Barangay illustrate the statistical distribution of swine detected with ASF-related symptoms, and those confirmed positive for ASF across different barangays. The first chart shows the barangays with reported symptomatic cases, while the second chart presents the number of cases confirmed positive through laboratory testing. Generating statistical reports through the integrated data analysis computerized system lies in its ability to provide accurate, timely, and actionable information. The Project SwineScan computer system not only improve surveillance and monitoring efforts but also strengthens policy-making, disease management, and community awareness in addressing the ASF outbreaks in the municipality or in the province.



Figure 7: Statistical Report for Positive with Symptoms per Barangay, Positive and Confirmed with ASF Per Barangay.
Source: Authors, (2026).

Figure 8 A Statistical Report for Positive with Symptoms in Every Municipality and a Statistical Report for Positive with Symptoms in Every Municipality. Figures 8A and 8B illustrate the statistical distribution of ASF (African Swine Fever) cases at the municipality level, distinguishing between swine detected with symptoms and those confirmed positive through laboratory testing. By generating charts and summaries, stakeholders can grasp the overall situation at a glance, thereby facilitating rapid policy formulation and emergency response. The pie charts provide a clear distribution of cases across municipalities, allowing authorities to monitor the spread of ASF geographically and anticipate potential spillover to adjacent areas.

The municipality-level reports through the computerized system lie in its role as a decision-support mechanism. It ensures that ASF management is evidence-based, efficient, and responsive to the varying conditions across -municipalities. By integrating symptom-based monitoring with laboratory confirmations, the system not only improves accuracy but also empowers stakeholders to implement targeted interventions that minimize economic losses and protect food security. Reports can be easily shared between local governments, regional offices, and national agencies, promoting synchronized efforts in disease control. The system also supports historical data archiving, enabling trend analysis that can inform long-term strategies for ASF prevention and preparedness.

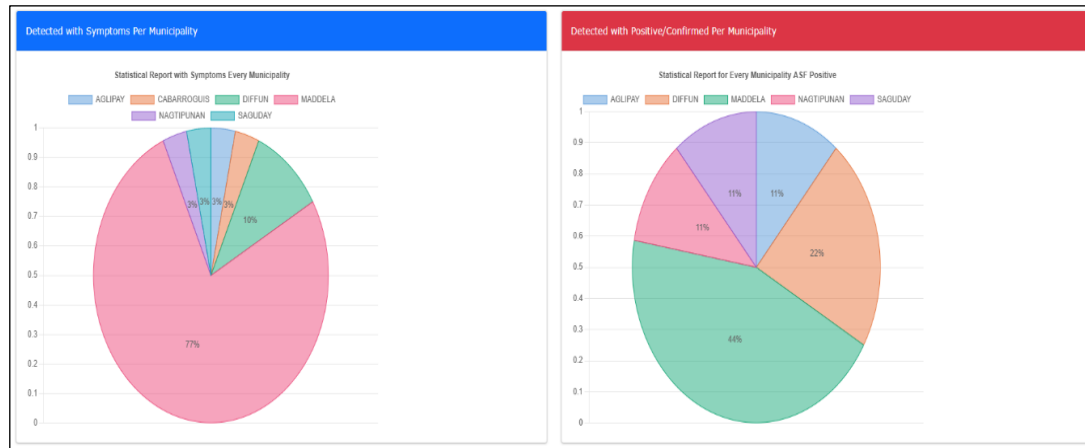


Figure 8: Statistical Report for Symptoms in Every Municipality and a Statistical Report for Positive in Every Municipality.
Source: Authors, (2026).

Figure 9. GIS Map and Monitoring using the sample data sets to illustrate the spatial distribution of confirmed cases. The map was generated using GIS-based methods using sample test datasets incorporating barangay boundaries, municipal halls/provincial office/BAI-Quirino Office, and confirmed case attributes. Geographic information systems (GIS) provide easy access, utilization, and manipulation of geospatial information. The advantage of GIS is mapping the many different locations of farms and other facilities with animals on a single map, which helps in better monitoring and surveillance [45].

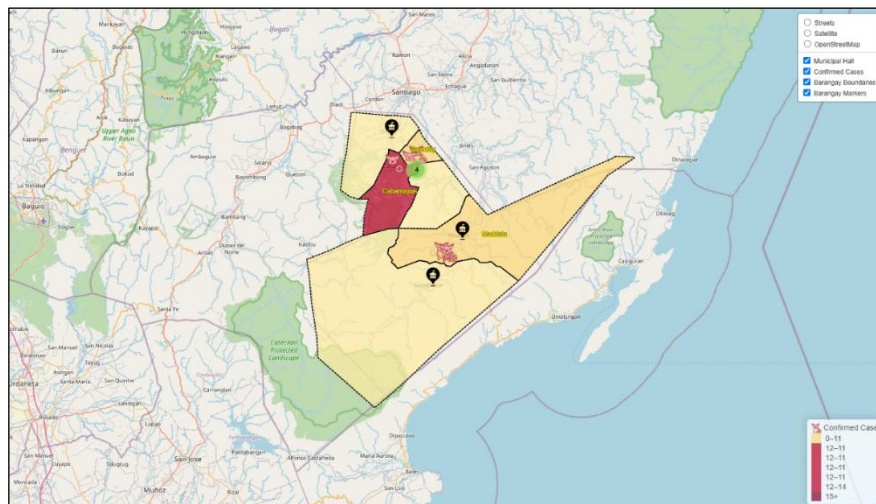


Figure 9: GIS Map and Monitoring.
Source: Authors, (2026).

V. CONCLUSIONS

The developed and tested Project SwineScan: IoT Technology Scanner for Common Symptoms of African Swine Fever, along with its integrated information system and GIS-enabled analytics. The system demonstrated that combining IoT sensing, automated reporting, and spatial visualization can significantly enhance ASF surveillance and control. The results confirmed that the prototype device is capable of contactlessly measuring critical swine health parameters such as body temperature, heart rate, and oxygen saturation. These physiological indicators were essential in detecting early symptoms of ASF, thereby reducing the delay typically associated with conventional diagnostic methods. The integration of GIS mapping and analytics further enhanced the system's utility by spatially visualizing ASF case distributions. This spatial perspective allowed stakeholders to identify hotspots, predict potential spillover risks, and prioritize high-risk zones for intervention. Project SwineScan proved to be more than a monitoring tool; it functioned as a decision-support system for multiple stakeholders, including farmers, local government units, veterinary authorities, and policymakers.

Its capacity for real-time data collection, automated reporting, and spatial analysis underscores its potential to minimize ASF's economic and social impacts while strengthening the overall resilience of the swine industry. The development and implementation of the Project SwineScan system present significant implications for swine health management, disease prevention, and agricultural technology advancement. As an IoT-based monitoring solution, Project SwineScan demonstrates how embedded systems and wireless technologies can be applied in livestock production to detect early indicators of African Swine Fever (ASF) and support timely interventions. The project serves as a valuable reference for future studies in smart farming, IoT applications, and embedded systems for agricultural use. It highlights the importance of interdisciplinary collaboration between Information Technology and Animal Science experts, as demonstrated in the testing and evaluation phase of this research. Project SwineScan system has the potential to contribute to sustainable livestock management, improved farm productivity, and ASF outbreak mitigation by providing a reliable, real-time, and contactless monitoring solution that empowers both farmers and veterinary professionals.

Further enhancements and research directions are necessary to maximize the efficiency, accuracy, and scalability of Project SwineScan. Expand the device to measure other physiological and behavioral parameters such as respiratory rate, locomotion patterns, and feeding behavior, which can serve as complementary indicators of ASF and other swine diseases. Incorporate the AI-driven algorithms that are capable of analyzing longitudinal health data to detect anomalies, predict outbreak risks, and provide automated alerts for early disease intervention. Establish interoperability with existing livestock monitoring platforms and national veterinary information systems to contribute to a unified and standardized ASF surveillance network. Adapt the system to monitor additional swine diseases such as Classical Swine Fever (CSF) and Porcine Reproductive and Respiratory Syndrome (PRRS). Future modifications may also extend its application to other livestock sectors such as cattle, poultry, or goats.

VI. AUTHOR'S CONTRIBUTION

Conceptualization: Winston G Domingo, Carmela G Blando and Dennie T Ruma.

Methodology: Winston G Domingo, Carmela G Blando.

Investigation: Carmela G Blando and Dennie T Ruma

Discussion of results: Winston G Domingo, Carmela G Blando and Dennie T Ruma.

Writing – Original Draft: Winston G Domingo, Carmela G Blando.

Writing – Review and Editing: Winston G Domingo, Carmela G Blando.

Resources: Carmela G Blando and Dennie T Ruma.

Supervision: Carmela G Blando and Dennie T Ruma.

Approval of the final text: Winston G Domingo, Carmela G Blando and Dennie T Ruma.

VII. ACKNOWLEDGMENTS

The researchers would like to express our sincere gratitude to the individuals and institutions whose support and contributions made this study possible. First and foremost, we extend our heartfelt appreciation to the Information Technology and Animal Science experts who generously shared their time, knowledge, and expertise in contributing to and evaluating our documents, technology, and system. Their constructive feedback and professional insights were invaluable in refining and validating the functionality and reliability of the project. The researchers acknowledge Quirino State University – Maddela Campus for providing the academic environment, facilities, and institutional support that greatly facilitated this study's conduct. A Special recognition was given to the Ideatech Challenge 2024, where this project was awarded 3rd Place, a testament to the relevance, innovation, and potential impact of the system in the fields of agriculture and information technology. Finally, the researchers extend their deepest gratitude to their families, colleagues, and mentors for their encouragement and unwavering support throughout the duration of this study.

VIII. REFERENCES

- [1] S. Costard, L. Mur, J. Lubroth, J. M. Sanchez-Vizcaino, and D. U. Pfeiffer, "Epidemiology of African swine fever virus," *Virus Research*, vol. 173, no. 1, pp. 191–197, Apr. 2013, doi: <https://doi.org/10.1016/j.virusres.2012.10.030>.
- [2] J. M. Sánchez-Vizcaino, A. Laddomada, and M. L. Arias, "African Swine Fever Virus," *Diseases of Swine*, pp. 443–452, Mar. 2019, doi: <https://doi.org/10.1002/9781119350927.ch25>.
- [3] A. Karger et al., "An Update on African Swine Fever Virology," *Viruses*, vol. 11, no. 9, p. 864, Sep. 2019, doi: <https://doi.org/10.3390/v11090864>.
- [4] L. K. Dixon, H. Sun, and H. Roberts, "African swine fever," *Antiviral Research*, vol. 165, pp. 34–41, May 2019, doi: <https://doi.org/10.1016/j.antiviral.2019.02.018>.
- [5] C. P. Fernandez-Colorado, Woo Hyun Kim, R. A. Flores, and W. Min, "African Swine Fever in the Philippines: A Review on Surveillance, Prevention, and Control Strategies," *Animals*, vol. 14, no. 12, pp. 1816–1816, Jun. 2024, doi: <https://doi.org/10.3390/ani14121816>.
- [6] H. J. Bakke, A. D. Perez, R. Miclat-Sonaco, A. M. Perez, and R. A. Schambow, "Mental health impacts of African swine fever outbreaks on veterinarians in the Philippines," *Frontiers in Veterinary Science*, vol. 12, Mar. 2025, doi: <https://doi.org/10.3389/fvets.2025.1519270>.
- [7] J. Michael, A. Paul, G. Maria, A. Salamat, T. N. Agulto, and C. P. Fernandez-Colorado, "Risk scoring of African swine fever transmission in selected provinces of the Philippines," *Journal of Veterinary Science*, vol. 26, no. 1, Dec. 2024, doi: <https://doi.org/10.4142/jvs.24149>.
- [8] K. Liang and M. Wang, "Biosafety management system for pig farms based on deep learning and internet of things technology," 2021 China Automation Congress (CAC), pp. 4978–4983, Nov. 2024, doi: 10.1109/cac63892.2024.10864547
- [9] P. Suebsairom, T. Satiramekul and A. Engkaninan, "Swine Body Temperature Monitoring System," 2023 International Electrical Engineering Congress (iEECON), Krabi, Thailand, 2023, pp. 188–192, doi: 10.1109/iEECON56657.2023.10127042.
- [10] C. Gallardo et al., "Assessment of African swine fever diagnostic techniques as a response to the epidemic outbreaks in Eastern European Union Countries: How to improve surveillance and control programs," *Journal of Clinical Microbiology*, vol. 53, no. 8, pp. 2555–2565, Jun. 2015, doi: 10.1128/jcm.00857-15
- [11] L. K. Dixon, H. Sun, and H. Roberts, "African swine fever," *Antiviral Research*, Vol. 165, pp. 34–41, 2019.
- [12] T. Kim, M. Hong, and J. Shin, "Development of an Early Diagnostic Device for African Swine Fever through Real-time Temperature Monitoring Ear-tags (RTMEs)," *Journal of Sensor Science and Technology*, vol. 32, no. 5, pp. 275–279, Sep. 2023, doi: 10.46670/jsst.2023.32.5.275.
- [13] Karthick GS, Sridhar M, Pankajavalli PB (2020). Internet of Things in Animal Healthcare (IOTAH): Review of recent advancements in architecture, sensing technologies and Real-Time Monitoring. *SN Computer Science*. 1. - doi: 10.1007/s42979-020-00310-z
- [14] Almazan VKB, Mahipus FIB, Santos JRM, Samonte MJC (2020). CAHM. Proceedings of the 2020 11th International Conference on E-Education, E-Business, E-Management, and E-Learning. (pp. 417–421). - doi: 10.1145/3377571.3377641

- [15] Kumari S, Yadav SK (2018). Development of IoT based smart animal health monitoring system using Raspberry Pi. SSRN Electronic Journal. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3315327
- [16] S. Blome, K. Franzke, and M. Beer, "African swine fever – A review of current knowledge," *Virus Research*, vol. 287, p. 198099, Aug. 2020, doi: 10.1016/j.virusres.2020.198099.
- [17] C. Muñoz-Pérez, C. Jurado, and J. M. Sánchez-Vizcaíno, "African swine fever vaccine: Turning a dream into reality," *Transboundary and Emerging Diseases*, vol. 68, no. 5, pp. 2657–2668, Jun. 2021, doi: 10.1111/tbed.14191
- [18] H. Bergmann et al., "Identification of risk factors for African swine fever: a Systematic review," *Viruses*, vol. 14, no. 10, p. 2107, Sep. 2022, doi: 10.3390/v14102107.
- [19] M. S. Beato, F. D'Errico, C. Iscaro, S. Petrini, M. Giammarioli, and F. Feliziani, "Disinfectants against African Swine Fever: An Updated Review," *Viruses*, vol. 14, no. 7, p. 1384, Jun. 2022, doi: 10.3390/v14071384
- [20] M. Martínez-Avilés, E. Fernández-Carrión, J. M. L. García-Baones, and J. M. S. Vizcaíno, "Early Detection of Infection in Pigs through an Online Monitoring System," *Transboundary and Emerging Diseases*, 2015, doi: 10.1111/tbed.12372
- [21] J. Fernández-Pinero et al., "Molecular Diagnosis of African Swine Fever by a New Real-Time PCR Using Universal Probe Library," *Transboundary and Emerging Diseases*, vol. 60, no. 1, pp. 48–58, 2012, doi: 10.1111/j.1865-1682.2012.01317.
- [22] R. Schambow et al., "Modeling the accuracy of a novel PCR and antibody ELISA for African swine fever virus detection using Bayesian latent class analysis," *Frontiers in Veterinary Science*, vol. 10, p. 1079918, 2023, doi: 10.3389/fvets.2023.1079918.
- [23] H. W. Ryu and J. H. Tai, "Object detection and tracking using a high-performance artificial intelligence-based 3D depth camera: towards early detection of African swine fever," *Journal of Veterinary Science*, vol. 23, no. 1, Dec. 2021, doi: 10.4142/jvs.21252.
- [24] X. Zhao, R. Tanaka, A. S. Mandour, K. Shimada, and L. Hamabe, "Remote Vital Sensing in Clinical Veterinary Medicine: A Comprehensive Review of Recent Advances, Accomplishments, Challenges, and Future Perspectives," *Animals*, vol. 15, no. 7, p. 1033, 2025, doi: 10.3390/ani15071033.
- [25] J. T. Kelly, K. L. Campbell, E. Gong, and P. Scuffham, "The Internet of Things: Impact and implications for Health care delivery," *Journal of Medical Internet Research*, vol. 22, no. 11, p. e20135, Sep. 2020, doi: 10.2196/20135.
- [26] R. Gomasa, "Importance and applications of GIS in engineering," *Indian Journal of Structure Engineering*, vol. 1, no. 1, pp. 4–8, Apr. 2021, doi: 10.35940/ijse.b8008.051121.
- [27] T. Jung et al., "Metaverse for service industries: Future applications, opportunities, challenges and research directions," *Computers in Human Behavior*, vol. 151, p. 108039, Nov. 2023, doi: 10.1016/j.chb.2023.108039.
- [28] G. Airapetian, "Rapid Application Development (RAD)," *Trusted Local Appliance Repair, Electrical & Plumbing Experts*, Dec. 14, 2022. <https://www.agilelonestar.com/knowledge-base/rapid-application-development>
- [29] P. A. Laplante and M. H. Kassab, *Requirements Engineering for software and systems*. 2022. doi: 10.1201/9781003129509.
- [30] A. K, R. Anand, S. D. Prabhu, and G. R. S, "IoT based Smart Healthcare System to Detect and Alert Covid Symptom," 2022 7th International Conference on Communication and Electronics Systems (ICCES), pp. 685–692, Jul. 2021, doi: 10.1109/icc51350.2021.9488952.
- [31] R. S. Pressman and B. R. Maxim, "Software Engineering: A Practitioner's Approach, 8/E International Edition," Palgrave Macmillan, Jun. 2016, [Online]. Available: <https://openlibrary.telkomuniversity.ac.id/home/catalog/id/115938/slug/software-engineering-a-practitioner-s-approach-8-e-international-edition.html>
- [32] X. Jia, "The role and importance of software testing in software quality management," *Journal of Industry and Engineering Management*, vol. 1, no. 4, pp. 39–44, Dec. 2023, doi: 10.62517/jiem.202303406.
- [33] A. D Beltran, A. M. Gallardo, K. S A, and P. M L, African swine fever: detection and diagnosis – A manual for veterinarians: A manual for veterinarians. FAO Animal Production and Health Manual No. 19, 19th ed. Food and Agriculture Organization of the United Nations (FAO), 2017. [Online]. Available: <https://openknowledge.fao.org/items/23d6498e-c97f-4959-a77b-9376a13bb6dd>
- [34] Sánchez-Cordón, P.J., Montoya, M., Reis, A.L. and Dixon, L.K., 2018. African swine fever: A re-emerging viral disease threatening the global pig industry. *The Veterinary Journal*, 233, pp.41-48.
- [35] G. C. Gianotti, W. K. Beheregaray, S. P. Bianchi, V. S. Mombach, A. B. Carregaro, and E. A. Contesini, "Suíno como modelo experimental na pesquisa biomédica: valores fisiológicos normais," *ACTA SCIENTIAE VETERINARIAE*, vol. 38, no. 2, p. 133, Jun. 2018, doi: 10.22456/1679-9216.16610.
- [36] J. Fernández-Pinero et al., "Molecular diagnosis of African swine fever by a new Real-Time PCR using Universal Probe Library," *Transboundary and Emerging Diseases*, vol. 60, no. 1, pp. 48–58, Mar. 2012, doi: 10.1111/j.1865-1682.2012.01317.x.
- [37] R. Schambow et al., "Modeling the accuracy of a novel PCR and antibody ELISA for African swine fever virus detection using Bayesian latent class analysis," *Frontiers in Veterinary Science*, vol. 10, Feb. 2023, doi: 10.3389/fvets.2023.1079918.
- [38] M. Wang et al., "Contactless Video-Based heart rate monitoring of a resting and an anesthetized pig," *Animals*, vol. 11, no. 2, p. 442, Feb. 2021, doi: 10.3390/ani11020442.
- [39] X. Zhao, R. Tanaka, A. S. Mandour, K. Shimada, and L. Hamabe, "Remote Vital Sensing in Clinical Veterinary Medicine: A comprehensive review of recent advances, accomplishments, challenges, and future perspectives," *Animals*, vol. 15, no. 7, p. 1033, Apr. 2025, doi: 10.3390/ani15071033.
- [40] M. Martínez-Avilés, E. Fernández-Carrión, J. M. L. García-Baones, and J. M. Sánchez-Vizcaíno, "Early Detection of Infection in Pigs through an Online Monitoring System," *Transboundary and Emerging Diseases*, vol. 64, no. 2, pp. 364–373, May 2015, doi: 10.1111/tbed.12372.

- [41] Y. Dong et al., PigV2: Monitoring Pig Vital Signs through Ground Vibrations Induced by Heartbeat and Respiration, vol. 7, p 1102–1108. Proceedings of the 20th ACM Conference on Embedded Networked Sensor Systems, Association for Computing Machinery, 2023, pp. 1102–1108. doi: 10.1145/3560905.3568416.
- [42] O. Vermesan et al., “Internet of Things Cognitive Transformation Technology Research Trends and applications,” in River Publishers eBooks, 2022, pp. 17–95. doi: 10.1201/9781003337584-3.
- [43] M. S. Farooq, O. O. Sohail, A. Abid, and S. Rasheed, “A survey on the Role of IoT in agriculture for the Implementation of Smart Livestock environment,” IEEE Access, vol. 10, pp. 9483–9505, Jan. 2022, doi: 10.1109/access.2022.3142848.
- [44] S. M. C. Porto, G. Castagnolo, F. Valenti, and G. Cascone, “Kernel density estimation analyses based on a low power GPS for monitoring environmental issues of grazing cattle,” Journal of Agricultural Engineering, Mar. 2022, doi: 10.4081/jae.2021.1323.
- [45] B. Tadesse and A. Amare, “Application of Geographical Information System in Animal Disease Surveillance and Control: a review,” Ethiopian Veterinary Journal, vol. 25, no. 1, pp. 128–143, Apr. 2021, doi: 10.4314/evj.v25i1.8.