



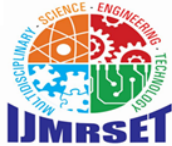
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IoT-Based Municipal Animal Welfare Management and Monitoring System

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ABSTRACT: The growing number of pet animals together with the obstacles that municipal animal welfare programs encounter creates a need for better systems to control and safeguard animal health and safety. The current methods used for tracking pets depend on people to manually observe and report their findings which leads to problems that include emergency response delays and lost pets and health issues that remain untracked so there exists a need for technological solutions. The research which carries the title "IoT-Based Municipal Animal Welfare Management and Monitoring System" developed a smart collar that uses Internet of Things (IoT) technology to track the health and temperature status and activities and real-time locations of pet dogs and cats. The system used the ESP32-C3 development board together with a heart rate sensor and temperature sensor and motion sensor and GPS module to gather necessary data. The system collected data which was transmitted through wireless networks to a web-based platform that allowed users to remotely monitor their pets. The system was evaluated through a survey questionnaire which was given to chosen participants for testing its performance and user experience and system dependability. The results showed mean scores which fell between 4.41 and 4.50 which the researchers interpreted as "Excellent" because users expressed high satisfaction with the system's operating abilities and available functions. The results demonstrate that the developed system provides an effective solution for municipal animal welfare management because it enables organizations to monitor their operations in real-time while also enhancing pet protection and educating pet owners about their responsibilities through IoT technology implementation which makes it a trustworthy and valuable modern animal care system solution.

KEYWORDS: Internet of Things (IoT), Smart Collar, Municipal Animal Welfare, Pet Monitoring System, GPS Tracking, ESP32-C3, Health Monitoring Sensors.

I. INTRODUCTION

Animal welfare is becoming more of a growing concern, mainly because the amount of stray animals is rising, and also domesticated ones are increasing. Pet owners, often have trouble keeping tabs on their pets health, their safety and even their location, while the LGUs still find it hard to handle animal welfare services since many tasks are still manual, plus the monitoring tools are limited.



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Some earlier work already suggested that manual record-keeping can make responses to animal welfare concerns slower (Horecka & Neal, 2022) [1]. While Mohanty et al. (2024) [2] showed, how IoT technologies could help in monitoring by sending real time data from sensors and tracking units .

This study proposes an IoT-based Municipal Animal Welfare Management and Monitoring System by using smart collars. The idea is to combine the GPS tracking, health and activity sensors, and alert notifications in a single place, so local governments can strengthen animal safety, enhance the way they assess the situations, and respond faster, all through real time technology.

II. LITERATURE REVIEW

The advancement of Internet of Things (IoT) together with smart sensing and ongoing monitoring has helped bring about systems that, well, boost animal welfare, keep a closer eye on health, and support location tracking. A number of studies look into how sensors, wireless links, and real-time monitoring platforms can work together, for more efficient and dependable care of pets plus other animals. In practice, these setups allow near-constant surveillance, faster identification of early warning signs, and a quicker reaction when emergencies happen, so they become quite useful for today's animal welfare programs.

Ozger et al. (2024) [3] discussed the increasing adoption of Internet of Things (IoT) technologies for monitoring and management setups. From their point of view it's the interlinked devices plus real-time data acquisition that tend to boost overall efficiency, raise monitoring accuracy, and shorten response time. They also pointed out that smart technologies are really useful for continuous observation and more centralized data handling, and that this can help multiple uses, like health related applications and animal welfare systems, even when the needs are different.

Chen et al. (2022) [4] developed an intelligent pet protection system using IoT devices, for keeping a closer eye on animal health and activity. In practice the system relies on a set of sensors, plus wireless communication technologies, to gather and forward real time data like temperature, motion, and location. Their work showed how an IoT based setup can help with pet safety and at the same time give timely updates to pet owners via constant monitoring.

Taer and Taer (2025) [5] looked into how precision livestock farming and IoT technologies are actually carried out in the Philippines. Their work is centered on the way smart tools help with animal observation, health management, and data getting in today's agricultural routine. The researchers noted that IoT devices increase efficiency and decision-making by allowing for real-time monitoring and automated management operations.

Palaog et al. (2024) [6] looked into how digital and technology based methods can be used to improve animal welfare, and overall monitoring. In their study they pointed out how important it is to bring in smart technologies, and to use more centralized platforms , so management and reporting can stay efficient and not fall apart. The researchers also underlined that technology-driven solutions can strengthen monitoring accuracy, make information easier to reach, and support the animal welfare services in general.

Aziz et al. (2023) [7] came up with an IoT smart collar, that tracks pets health along with their location in real time. The whole system links GPS, Wi-Fi, and a set of sensors, so it can follow pet movement, track temperature, and also observe activity levels. In their work it was shown that these wearable IoT devices give continuous monitoring and they can enhance pet safety, because owners are able to check up on real time data about their pets, even when they are not nearby.

Table 1. Summary of Relevant Literature

No.	Paper Title	Author Name	Key Points	Remark
3	IoT-Based Smart Monitoring and Management Systems	Ozger et al., 2024	Discussed the use of IoT in monitoring systems.	The study is relevant because it shows how IoT technologies can help monitoring systems, with real time data collection and centralized management, and this actually supports the building of



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				the proposed animal welfare monitoring system. In other words it connects those same mechanisms to the idea that better supervision can happen faster, and with more careful control.
4	Intelligent Pet Protection System Based on IoT Devices	Chen et al., 2022	Developed an IoT-based pet monitoring system.	The study is related to the proposed system because it shows how IoT devices and sensors can be used for continuous pet monitoring and real-time data transmission.
5	Harnessing Precision and Innovation: A Systematic Review of Precision Livestock Farming and IoT Technologies in the Philippines	Taer & Taer 2025	Reviewed IoT technologies used in animal monitoring.	The study supports the proposed research by emphasizing the importance of IoT technologies in improving animal monitoring, management, and decision-making systems.
6	Technology-Based Animal Welfare and Monitoring Systems	Palaog et al., 2024	Highlighted centralized monitoring platforms.	This study is important to the system that is proposed, because it points out how digital technologies can boost animal welfare services and also help with monitoring routines.
7	IoT-Enabled Activity Tracking Collar for Cats with GPS Localization	Aziz et al., 2023	Used GPS, Wi-Fi, and sensors for tracking pets.	It is relevant, since it shows the practical impact of wearable IoT devices for tracking a pet's whereabouts and keeping an eye on health situations in real time.

Overall, the reviewed studies show that IoT and smart technologies help animal welfare by means of real-time monitoring, GPS tracking, and health monitoring systems. In practice, they improve the way information is caught, with faster response time, and better data management, which supports a more efficient animal welfare governance, and in general more reliable oversight.

III. METHODOLOGY OF PROPOSED SURVEY

Research Design:

The study used a developmental descriptive research method to guide both the making and the checking of the IoT based Municipal Animal Welfare Management and Monitoring System. The development side helped in designing and building smart collars with real time location plus vital sign and activity monitoring, and also adding modules for pet registration, information handling, and emergency notifications, meant for LGUs and pet owners. Then the descriptive part was applied so the researchers could look at how the system works in practice, its usability, reliability, responsiveness, and accuracy, including tracking, health monitoring, keeping of records and the delivery of alerts. Also, feedback from LGU staff and pet owners was collected, to see if the system was easy to use and truly helpful in improving animal welfare management.

Instruments:

The testing phase used quantitative feedback forms to assess the system's performance, which included smart collars. The study distributed these forms to pet owners and non-pet owners to evaluate their satisfaction with the system's usability, effectiveness, and overall user experience. The questionnaire focused on critical parameters such as functionality, accuracy, efficiency, and reliability, providing structured data to determine how effectively the system supports an IoT-based Municipal Animal Welfare Management and Monitoring System.

Data Collection and Participants:

A total of 50 participants from the Municipality of Cantilan, Surigao del Sur, were selected to evaluate the system, including 20 pet owners, 20 non-pet owners, 5 NEMSU students, and 5 IT practitioners. The survey evaluated the prototype through testing its operational ability, user experience, system dependability, and overall system acceptance.



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The research team gathered completed questionnaires, organized and analyzed them using quantitative methods to derive their findings.

Data Analysis:

The survey responses were collected, organized, and examined using basic quantitative methods. The researchers assigned numerical values to each response, enabling them to summarize the results. The data analysis employed weighted means and frequencies, along with percentage methods, to assess how pet owners and non-pet owners evaluated the Smart Collar System in terms of functionality, usability, reliability, and overall acceptability. The findings were then used to assess the system's effectiveness and potential for adoption.

1. Weighted mean This method was used to figure out the average evaluation scores for the Smart Collar System when it comes to functionality, usability, reliability, efficiency, and the overall acceptability. The scores came from the assessments provided by pet owners along with non-pet owners.
2. Frequency distribution This was applied to see the count of responses logged for each evaluation indicator and for every respondent category, so you can tell what people picked most often or least often.
3. Percentage distribution. This one was used to determine the share of responses per evaluation criterion, and it also helped in giving a summarized interpretation of how the respondents viewed the items presented to them.
4. Verbal interpretation. The computed mean values were then interpreted by using a qualitative descriptive scale, which helped identify the level of performance effectiveness and acceptability of the developed Smart Collar System.

IV. RESULTS AND DISCUSSION

System Features

The system has a real-time pet monitoring setup that uses IoT so users can monitor the pet's location, vital signs, and activity levels through a website. It relies on sensors to gather real data on the pet's heart rate, temperature, and activity levels. At the same time, a GPS module gives fairly precise location tracking, which helps keep everything more steady and reliable. On top of that, the system comes with alerts that is being sent through Telegram when something abnormal is being detected. All of this helps boost pet safety, makes monitoring easier, and supports better overall animal welfare management.

Performance Evaluation

The evaluation of performance showed that the IoT-based Municipal Animal Welfare Management and Monitoring System worked effectively, regarding functionality, reliability, accuracy, and efficiency. It got Excellent ratings for real-time monitoring, GPS tracking, vital sign monitoring, emergency alerts, and the dashboard management. In general, these results confirm that the system is reliable, accurate, and efficient when it comes to supporting animal welfare monitoring and management.

Table 2 Summary of Smart Collar System Evaluation

Table	Quality Characteristic	Mean	Verbal Interpretation
1	Functionality	4.512	Excellent
2	Reliability	4.408	Excellent
3	Accuracy	4.432	Excellent
4	Efficiency	4.54	Excellent

The results show that the system obtained an "Excellent" rating in all quality characteristics. Efficiency obtained the highest mean score of 4.540, indicating that the system performs tasks effectively. Functionality followed with a mean score of 4.512, showing that the features of the system meet its intended purpose. Accuracy received a mean score of 4.432, which indicates that the system provides correct and dependable data. Reliability obtained a mean score of 4.408, showing that the system performs consistently. Overall, the findings indicate that the Smart Collar System is effective and highly acceptable for pet monitoring and animal welfare management.



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V. CONCLUSION

Researchers created an Internet of Things (IoT) system that tracks animal welfare in cities using a smart collar that monitors cats' and dogs' health, movement, and location in real time. The system used an ESP32-C3 development board to connect multiple sensors, including a heart rate sensor, motion sensor, temperature sensor, and GPS module. The web-based platform receives the collected data, enabling users to monitor the animal's current status.

The evaluation results from the conducted survey showed that the developed system achieved computed mean values ranging from 4.41 to 4.50, interpreted as "Excellent." The respondents found the system highly acceptable across its three main aspects: functionality, reliability, and usability, as well as overall performance. The proposed system successfully enables pet monitoring while enhancing animal safety and welfare.

The team's smart collar delivers an effective solution for pet owners and municipal animal welfare offices to monitor pets reliably and efficiently. The system establishes a research base for future work on the development of an IoT-based Municipal Animal Welfare Management and Monitoring System, integrated with a smart collar.

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