

# Smart Pet Travel: An IoT-Integrated Carrier Box for Safety and Comfort

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## Abstract

This paper presents the design, fabrication, and evaluation of an Internet of Things (IoT)-enabled pet carrier box aimed at improving safety, comfort, and convenience during animal transport. The system integrates automated temperature-controlled ventilation, real-time monitoring, and GPS tracking. Evaluation results demonstrate excellent performance in design, functionality, safety, and user satisfaction. IoT Application Pet Carrier Box is a device transport mechanism that aims to improve pet surveillance, comfort, and travel security. Despite growing demand for pet mobility solutions, existing pet carriers lack integrated systems for temperature regulation, ventilation, and real-time tracking, revealing a gap in the market for intelligent carrier designs. This paper introduces the design, development, and testing of an IoT-enabled pet carrier with features such as temperature sensors, a ventilation system, a pet monitoring camera, and GPS tracking, all controlled through a mobile app. The carrier is made with a durable Stuco body and an aluminum screen frame for strength and mobility, and it can hold small to medium-sized pets comfortably. An integrated single-fan air circulation system, triggered by a temperature sensor, automatically operates when ambient temperatures reach above 35°C, ensuring a secure environment and avoiding overheating. An A9 mini night-vision camera and real-time temperature reading provide ongoing monitoring, with location tracking of the carrier facilitated by a GPS tracker. Battery tests verified that a 12V lithium-ion battery is adequate for powering the system, though power management improvements are suggested to maximize operational time. Experimental results support the performance and responsiveness of IoT devices. In general, this study illustrates the practicality of IoT in pet transport as a technologically enhanced alternative to traditional pet carriers. Future development will concentrate on enhanced cooling performance and energy efficiency to further heighten usability and performance.

**Keywords:** Industrial Technology, pet carrier box, Internet of Things, monitoring system, smart transport, pet safety, experimental-developmental method, Southern Leyte.

## 1. Introduction

The rising population of domestic and international pet owners has emphasized more humane, safe, and convenient animal transportation (Pinillos, 2018). Conventional pet carriers like bayong, backpacks, and wire cages are still used in the Philippines. Though conventional pet carriers perform transportation

tasks, they may be deficient in vital features such as proper ventilation, temperature regulation, and structural comfort. This concern is particularly pressing regarding distant travel or long periods of restriction, which can lead to stress, discomfort, or even health threats to animals (Bhatt et al., 2021). Globally, organizations like the World Organization for Animal Health (WOAH) have emphasized the importance of advancing animal welfare during transport (Giangaspero & Turno, 2024). Locally, humane treatment while handling and transporting is mandated under the Philippine Animal Welfare Act (RA 8485). However, these are not always translated into practical equipment available to breeders, pet owners, or transporters, and therefore, identify a gap between policy and practice.

This growing interest in animal welfare in transport has resulted in various technological innovations, particularly in stay-at-home pet care. Present literature has made tremendous strides in developing Internet of Things (IoT)-based pet care systems. For instance, smart feeding systems enable scheduled food dispensing even in the owner's absence (Sujatha et al., 2024). Equally, technologies such as real-time health monitoring sensors for pet rehabilitation cages (Salsabila & Adziimaa, 2024), self-cleaning waste management and monitoring intelligent dog cages (Rey & Rey, 2024), and IoT-based mobile carriers with hygiene tracking and location tracking capabilities (Yoon & Yoon, 2023) are examples of the potential of technology in improving the welfare of animals being cared.

Despite these promising innovations, most are designed for stationary or home-based applications, with a limited focus on transport scenarios. Few, if any, studies have extended these technologies to mobile pet carriers that can regulate temperature, provide ventilation, and allow real-time tracking during travel. This gap presents a compelling opportunity to reimagine pet transport systems through the lens of smart technology.

This study offers a new pet carrier with electronic functionality for increased travel comfort, security, and convenience. It has an ergonomic shelving interior design that minimizes stress and facilitates easy mobility for pets. Additionally, it features an electronic ventilation system that responds to temperature changes by automatically activating cooling fans. Moreover, an inbuilt GPS tracking feature is provided for real-time tracking during transportation. By combining physical comfort with smart automation, this carrier raises the bar in pet transport and fills the loopholes of existing traditional models. This research provides a design within both theoretical and practical contributions. Theoretically, it contributes knowledge in smart animal handling and IoT-based care systems. It offers a working prototype for smart pet carriers grounded in engineering innovation and user-centered design. For this reason, this study has huge potential to pioneer new developments in animal welfare technology, particularly where mobility and convenience are at the top of mind.

## Theoretical Concept Background

The concept of Internet of thing carrier box for pet introduces a new level of sophistication in pet travel. These carriers would utilize a small computer chip to automate features and monitor pet well-being during transport. Here are some theories on how this technology will be anchored and could be implemented, drawing on established research in animal welfare:

### *Environmental Control*

Precise environmental control is a fundamental feature of Internet of things for pet carrier box. Sensors can monitor internal temperature and humidity, triggering heating or cooling elements to maintain a comfortable range. Ventilation fans may also adjust based on these readings, ensuring proper air

circulation and minimizing respiratory issues. This aligns with research by Weeks (2014), emphasizing the importance of thermal regulation for animal welfare during transport.

*Stress Reduction and Monitoring*

Minimizing pet stress during travel is another essential theory guiding Internet of things carrier. Built-in speakers could play calming music or familiar home sounds, while light therapy might simulate natural day-night cycles to regulate the pet’s sleep patterns. Sensors tracking pet activity and vocalizations could alert owners to signs of distress. Matsubara et al. (2017) demonstrated the effectiveness of music therapy in reducing animal stress, and Lamontan et al. (2006) showed how light therapy regulates circadian rhythms in humans, a concept that could be adapted for pets.

**Theoretical Framework of the Study**

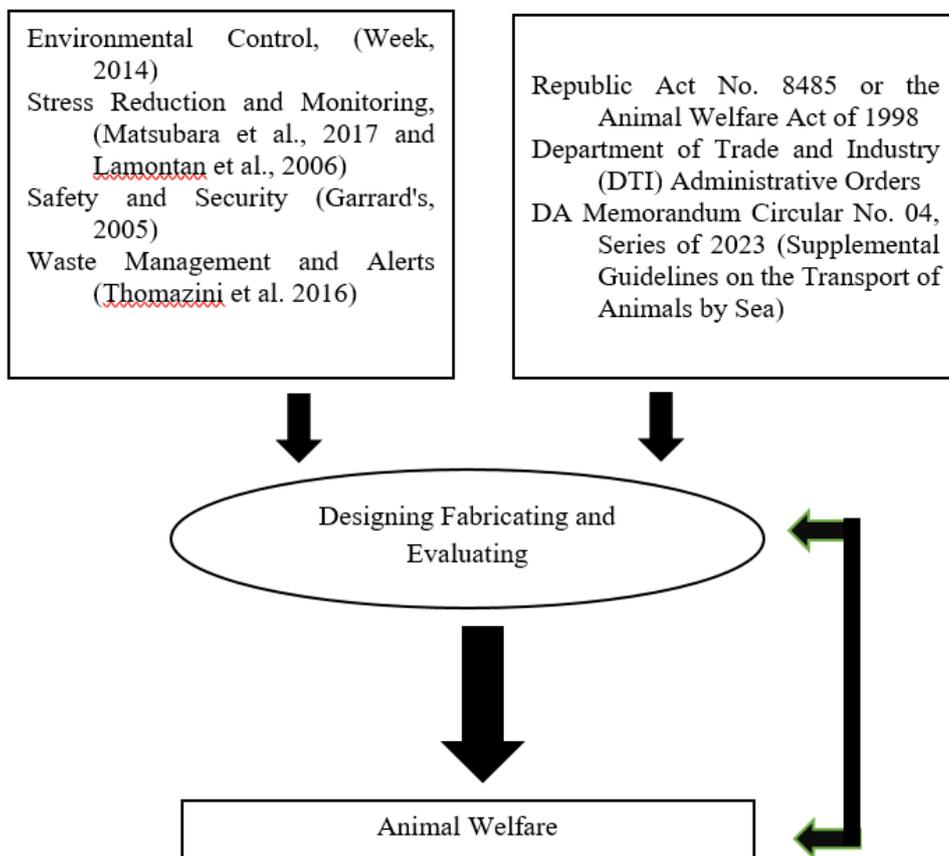


Figure 1. The Theoretical Framework of the Study

*Safety and Security*

Safety is prioritized through automated locking mechanisms and impact sensors. Locking systems prevent escapes, while impact sensors detect collisions and activate safety features or alerts. GPS tracking adds an extra layer of security, offering real-time location updates for owners. These features align with Garrard’s (2005) emphasis on proper handling and secure environments to minimize stress and injury during transport.

## *Waste Management and Alerts*

Sophisticated waste management systems can detect waste accumulation and activate self-cleaning mechanisms or notify owners when cleaning is required. Additionally, temperature sensors can monitor waste output, signaling potential health issues. According to Thomazini et al. (2016), monitoring waste is an effective method for early detection of pet health problems, ensuring timely interventions.

These theories represent just a glimpse into the possibilities of micro-controller-powered pet carriers. By leveraging technology, we can create a more comfortable, safe, and stress-free travel experience for our furry companions.

The development of the micro-controller-based pet carrier box is guided by various theoretical frameworks and governmental policies aimed at ensuring alignment with industry standards and compliance with regulatory requirements. This approach prioritizes the welfare of animals, ensuring that their well-being is upheld as a paramount consideration throughout the development process.

## *The Internet of Things (IoT)*

According to Radouan Ait Mouha (2021), the Internet of Things (IoT), also known as the Internet of Objects, refers to the integration of everyday objects with the Internet through the addition of hardware and/or software, making them "smart" and capable of communicating with one another. This transformation allows for new forms of interaction between people and objects, as well as between objects themselves, revolutionizing daily life and elevating it to a more advanced standard of living.

According to Carter and Brown (2024), pet transportation will be completely transformed by the use of edge computing and IoT in smart pet carriers. Future pet carriers will have quicker reaction times and be able to make better decisions in real time for the comfort and safety of their pets by processing data locally rather than depending on cloud-based storage.

## *IoT Technology Overview*

The IoT ecosystem facilitates real-time communication and data exchange through interconnected devices, making it a cornerstone of smart systems. As highlighted by Chen et al. (2022), IoT systems consist of sensors, wireless communication modules, and cloud-based analytics that enable efficient data collection and decision-making. Recent advancements in IoT technologies, including low-power wide-area networks (LPWAN) and edge computing, have further improved the scalability and responsiveness of IoT solutions (Zhang & Liu, 2023). These developments are particularly relevant in enhancing pet carrier systems for better monitoring and control.

## *Smart Pet Carriers*

IoT-powered smart pet carriers have gained attention for their ability to address common challenges in pet transportation. Research by Lee et al. (2021) demonstrated the effectiveness of integrating temperature and humidity sensors to maintain optimal environmental conditions inside pet carriers. Similarly, advanced GPS tracking systems have been developed to provide real-time location updates, as discussed by Martinez and Patel (2023). These features ensure that pets are transported safely and owners remain informed throughout the journey.

Safety remains a critical concern in pet transportation. IoT-enabled pet carriers offer innovative safety mechanisms, such as impact detection, automated locking systems, and emergency notifications. According to Rahman et al. (2022), accelerometer sensors embedded in pet carriers can detect sudden

movements or impacts and notify owners immediately. Furthermore, integrated cameras and microphones allow remote monitoring, providing peace of mind to pet owners during transit (Park & Kim, 2024).

IoT applications prioritize user convenience by integrating features like mobile app control, voice commands, and automated systems. Research by Wang et al. (2023) highlighted that IoT-enabled pet carriers equipped with user-friendly mobile applications improve user engagement and satisfaction. These apps often include features such as customizable temperature settings, feeding schedules, and real-time notifications. Additionally, smart carriers with voice communication capabilities allow owners to interact with their pets remotely, as explored by Sharma et al. (2025).

Malek (2022) and Marsol (2021) stressed the importance of exhaust fans in closed containers to prevent temperature rise, thereby maintaining acceptable oxygen and gas ratios. Their insights extended to various concerns related to animal transportation, including cleanliness, dimensions, pricing, and material sustainability. Aral et al. (2014) further emphasized the critical role of a well-designed carrier box in mitigating stress levels during the transportation of derby cocks, considering factors such as transport distance, ambient temperature, and mortality rates.

Through addressing this issue, the researcher significantly enhances the existing pet carrier by incorporating advanced electronic devices controlled by Arduino and temperature sensors. This innovative approach ensures the wellness, comfort, and safety of pets during long journeys. Notably, this design sets itself apart from previous inventions by integrating a sophisticated electronic system, including an exhaust fan, which greatly improves breeder convenience and animal comfort during transport.

These theories represent just a glimpse into the possibilities of micro-controller-powered pet carriers. By leveraging technology, we can create a more comfortable, safe, and stress-free travel experience for our furry companions.

The development of the internet of things pet carrier box is guided by various theoretical frameworks and governmental policies aimed at ensuring alignment with industry standards and compliance with regulatory requirements. This approach prioritizes the welfare of animals, ensuring that their well-being is upheld as a paramount consideration throughout the development process.

The main purpose of the study was to design, Internet of things Based carrier box for pets in maintaining optimal internal temperature ensuring energy efficiency for transport safety and convenience

Specifically, this will seek to answer the following questions:

1. How is the Internet of things (IoT) carrier box for pets develop to the following technical requirements:
  - 1.1 Design;
  - 1.2 Specification; and
  - 1.3 Features?
2. How functional is the IoT based pet carrier box in terms of maintaining:
  - 2.1 optimal internal temperature and air circulation;
  - 2.2 energy efficiency; and
  - 2.3 stress reduction?
3. How effective and acceptable IoT based carrier box for pets in terms of:
  - 3.1 Ease of use;
  - 3.2 Safety; and
  - 3.3 User satisfaction?

4. Based on finding, what technology reference guide can be adopted to optimized the usability and operation of IoT based carrier box?

### **Significance of the Study**

The Internet of thing (Iot) carrier box for pets contribute to improving the safety, comfort, and monitoring of pets during transportation. By integrating smart features such as automated ventilation and GPS tracking, the device addresses the limitations of traditional pet carriers. This innovation offers practical benefits to the following:

**Pet Owners.** Provides a safer and more comfortable transport solution for pets through temperature control and proper ventilation. Offers peace of mind through real-time GPS tracking, allowing owners to monitor their pet's location during travel.

**Veterinarians.** Ensures pets arrive in better physical and mental condition, reducing stress-related complications during clinical visits. Facilitates safe transport of sick or recovering animals with a more stable and controlled environment.

**Pet Industry.** Introduces an innovative product that addresses current gaps in pet transportation, creating opportunities for new market offerings. Supports the advancement of smart pet care solutions, aligning with modern trends in animal welfare technology.

**Future Researchers.** Serves as a foundation for studies integrating IoT in animal care and transport systems. Opens up possibilities for further innovation and interdisciplinary research in engineering, animal science, and product design.

## **MATERIALS AND METHODS**

### **Research Design**

The researcher will employ developmental evaluative design, to thoroughly assess the efficiency, effectiveness, and functionality of the carrier box for pets. This approach will enable a comprehensive evaluation of the carrier's performance, ensuring it meets the highest standards of innovation and practicality for pet transportation.

### **Flow of the Study**

The study will be structured around the Input-Process-Output (IPO) model, a framework that guides the flow of activities. Initially, the inputs will be meticulously gathered, comprising an array of materials, tools, and equipment essential for crafting the innovative Internet of things carrier box. This comprehensive list includes items such as an aluminum material, exhaust fan, temperature sensor, battery, LCD display, camera, electronic module and GPS for tracking. These components form the foundational elements upon which the study unfolds.

The subsequent phase delves into the intricate process of conceptualization, design, fabrication, and rigorous evaluation of the device. This multifaceted process encapsulates the creative ingenuity and technical expertise required to bring the advanced carrier box for pets from concept to tangible reality. Each step is meticulously executed, ensuring precision and adherence to design specifications.

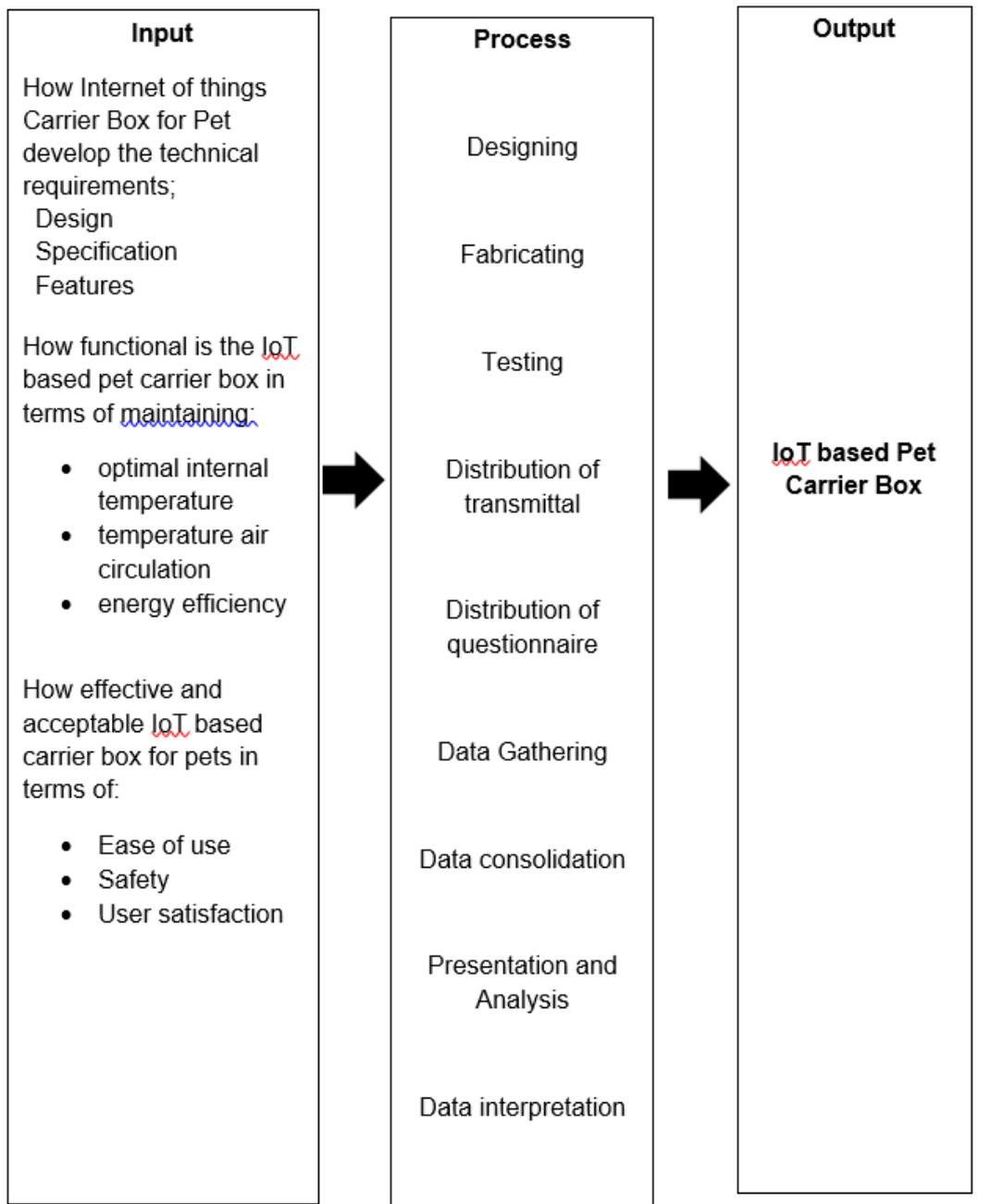


Figure 2. Flow of the Study

Finally, as the culmination of extensive research and development efforts, the study yields a tangible output in the form of the innovative carrier box for pets. This device stands as a testament to the efficacy of the Input-Process-Output model in guiding the research endeavor toward a practical solution. Its emergence marks a significant milestone, poised to address critical needs within the agricultural industry.

Recognized as a pivotal solution to the challenges faced by breeders, sellers, and pet owners, the micro-controller-based carrier box for pets emerges as a definitive demand pull. Its significance lies in its ability to streamline tasks, enhance efficiency, and, most importantly, prioritize safety in the workplace. By bridging this gap through the fabrication of such

equipment, the study not only meets the immediate demands of the industry but also paves the way for future innovations and advancements.

## Environment

This study will be conducted at Southern Leyte State University – San Juan Campus, situated at the Barangay San Jose of the municipality of San Juan, Southern Leyte. This campus offers a diverse range of programs, including Industrial Technology, Information Technology, Education, Business Management, and Accountancy. The selection of this location is strategic, leveraging the expertise available at the campus. The presence of knowledgeable professionals and experts in various fields provides an ideal environment for assessing the efficiency, effectiveness, and functionality of the micro-controller-based pet carrier box. Their insights and evaluations will be instrumental in ensuring the study's success and the carrier box's practical applicability.

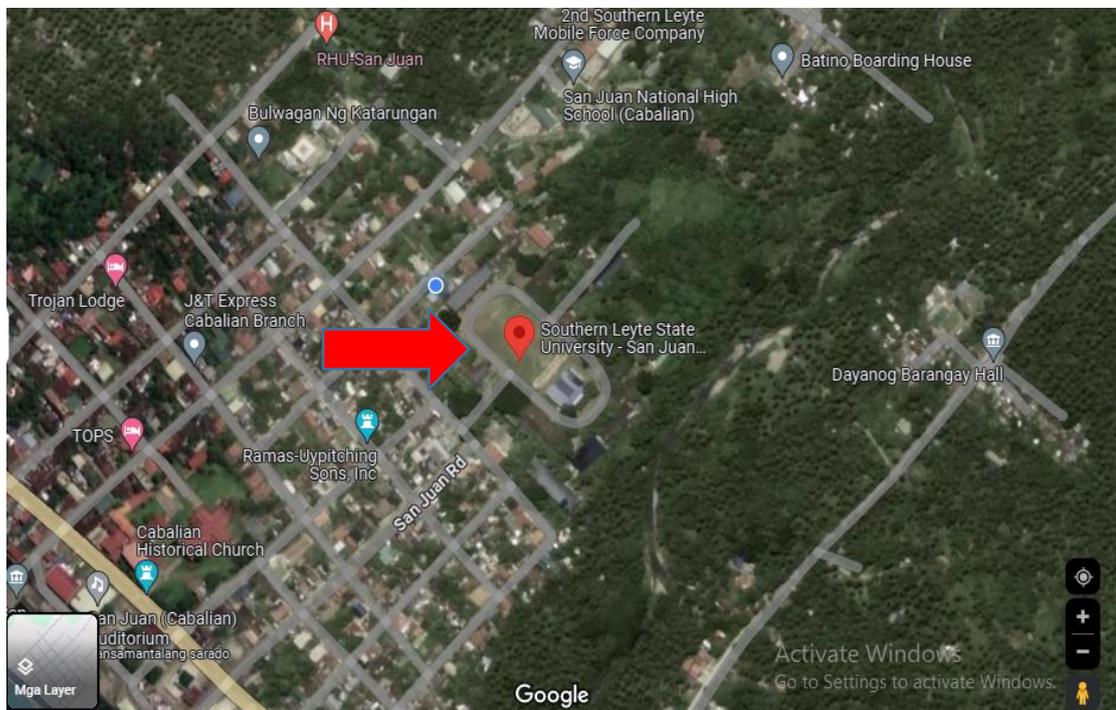
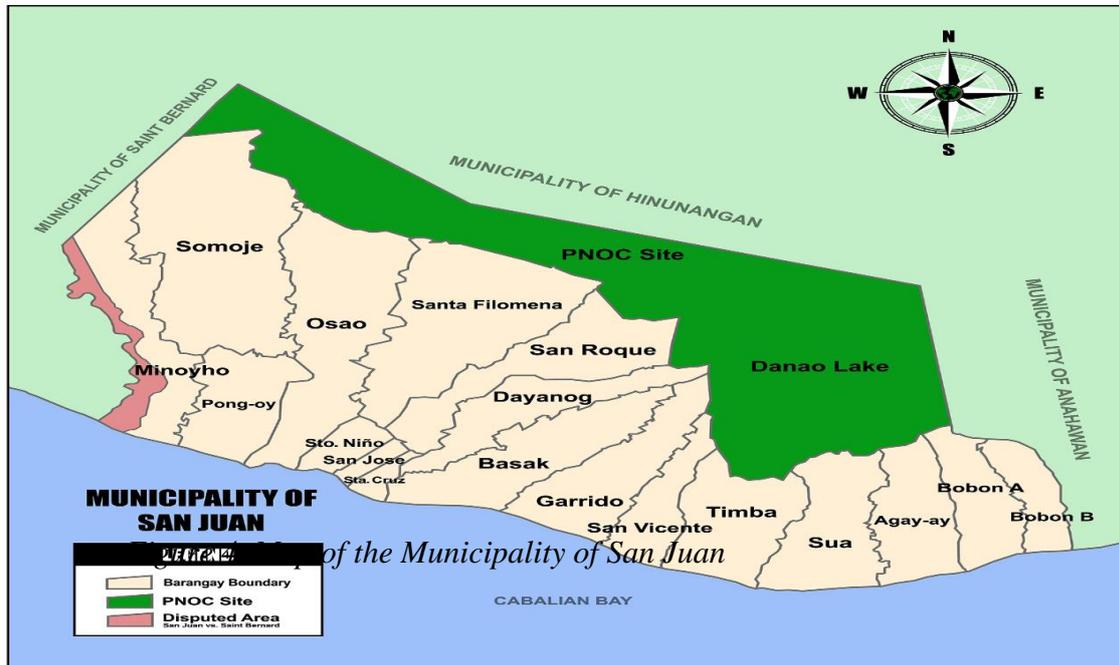


Figure 3. Aerial Image of the Southern Leyte State University – San Juan Campus



### Respondents of the Study

The study's respondents tasked with Internet of things carrier box for pets include faculty members from electronic, information technology, and electrical departments, as well as students from these disciplines. Additionally, industry professionals, breeders, and sellers from the municipality will be invited to participate. These individuals bring invaluable expertise and first-hand experience to the assessment process, enabling a comprehensive evaluation.

Their insights, perceptions, and feedback will serve as vital components in gauging the efficiency, effectiveness, and functionality of the device in real-world scenarios. Their diverse perspectives ensure that the study captures a wide range of considerations, from technical performance to usability and practicality in various operational contexts.

Table 1. Distribution of Respondents

Respondents Group		Population	%
Faculty	Electrical	2	4%
	Electronics	2	4%
	Info Tech.	2	4%
Students	Electrical	10	20%
	Electronics	10	20%
	Info Tech.	10	20%
Representatives from outside the campus	Industry	4	8%
	Breeders	5	10%
	Sellers	5	10%
Total		50	100%

**Instrument**

To gather data for this study, a comprehensive checklist with diverse questions will be administered to a range of respondents. The checklists, derived from previously published articles, aim to assess, functionality of the Internet of thing carrier box for pets.

The evaluation process involves various questionnaires, including the Modified Technology Acceptance Model (TAM) questionnaire by Cheah WH et.al. (2022), which assesses perceived usefulness, functionality, and other relevant aspects of the device. Additionally, questionnaires adapted from De Lone, W.H., and McLean, E.R. (1992) focus on device reliability, aligning with the Technology Acceptance Model (TAM) framework. The assessment of device safety incorporates questionnaires based on the TAM, incorporating safety standards, regulations, and ISO standards specific to the device's domain, such as ISO 45003:2021, providing guidelines for managing psychosocial risks in occupational health and safety. Lastly, the questionnaires used to evaluate the, functionality, and quality of the device's construction and designs are anchored to ISO/IEC 25010 standards, which assess the performance of the product.

On the other hand, assessing the effectiveness and efficiency of the Internet of things Carrier box involves a rigorous testing procedure. The device will undergo multiple trials with different pets, each housed for 12-hour intervals, and observations will be recorded at 1, 2, 3,12 and 24-hour marks. This methodical approach aims to measure how well the carrier box handles and monitors the welfare of animals. Throughout these trials, the carrier box practicality will be evaluated by meticulously documenting the housing process duration. This comprehensive testing framework will yield valuable insights into the device's performance, facilitating a thorough assessment of its effectiveness in real-world scenarios.

## Data Gathering Procedures

To uphold the validity of the study's findings, the researcher will implement a series of rigorous procedures throughout the data gathering phase. Initially, prior to commencing the evaluation, the researcher will draft a formal letter seeking permission from the respondents. This letter will succinctly articulate the study's objectives and request authorization for the evaluation of the carrier box within their respective facilities.

To address the objectives of this study, both developmental and evaluative approaches were employed. The data gathering process was conducted in four key stages aligned with the specific research questions of the study. The first stage involved the conceptualization and design of the IoT-based pet carrier box. During this phase, technical drawings, component selection, and system integration plans were documented. Data on the design, specifications, and features were collected through engineering documentation, prototype development records, and component testing to ensure that the device met its intended technical requirements.

The second stage focused on functionality testing to evaluate the carrier's performance in maintaining optimal internal temperature and air circulation. Temperature sensors and airflow meters were installed within the device, and its performance was tested under varying environmental conditions. Additionally, energy efficiency was assessed by measuring power consumption using a multimeter and battery monitoring tools.

In the third stage, the study evaluated acceptability of the fabricated prototype. The device was presented to a group of evaluators, including pet owners and veterinarians, who were asked to assess it using a structured Likert-scale questionnaire. The evaluation focused on three main criteria: ease of use, safety, and overall user satisfaction. Collected feedback was then analyzed and interpreted to determine how well the IoT-based pet carrier met user expectations and practical needs.

Upon receipt of the completed checklists, the researcher will meticulously examine, organize, tabulate, and interpret the gathered data utilizing appropriate statistical tools. By adhering strictly to these established protocols, the researcher endeavors to ensure the credibility and reliability of the collected data. This meticulous approach aims to enhance the validity of the study's results, facilitating the derivation of meaningful conclusions from the evaluation process.

### *Preparation of the Pet and Pet Carrier Box for Travel Testing and Evaluation*

#### **Part 1.**

Preparation for the Pet and Pet Carrier Box with absorbent fabric and Bamboo charcoal inside the box



**Part 2.** Setting the Pet Carrier box 12V 10A in Watt Metter setting 13.1V



**Part 3.** Start at 8:30am for travel in pet carrier box with 28°C - 29°C

Watt meter: 13:1V

Start time: 8:00am-9:45am

Temperature: Exceed to 35.3°C

Watt meter Volt: 12.7V

Fan: 31 Seconds



Watt meter: 12:7V

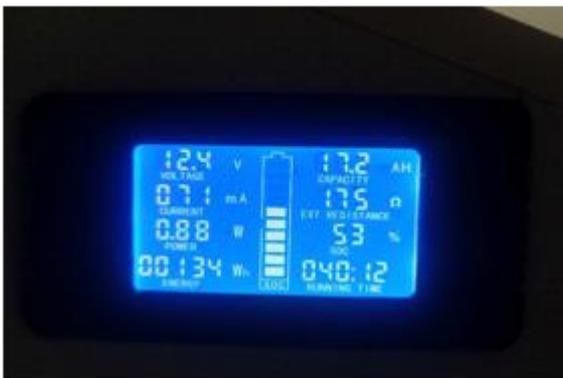
Start time: 9:45am-10:23



Temperature: Exceed to 35.4°C  
Watt meter Volt: 12.5V  
Fan: 4 minutes



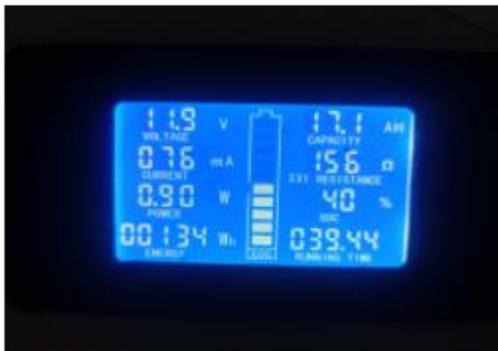
Watt meter: 12:5V  
Start time: 10:23am-11:10am  
Temperature: Exceed to 35.2°C  
Watt meter Volt: 12.4V  
Fan: 3 minutes



Watt meter: 12:4V  
Start time: 11:10am-12:03Pm  
Temperature: Exceed to 35.3°C  
Watt meter Volt: 12.2V  
Fan: 3 minutes



Watt meter: 12:2V  
 Start time: 12:3Pm-1:01Pm  
 Temperature: Exceed to 35.4°C  
 Watt meter Volt: 11.9V  
 Fan: 3 minutes



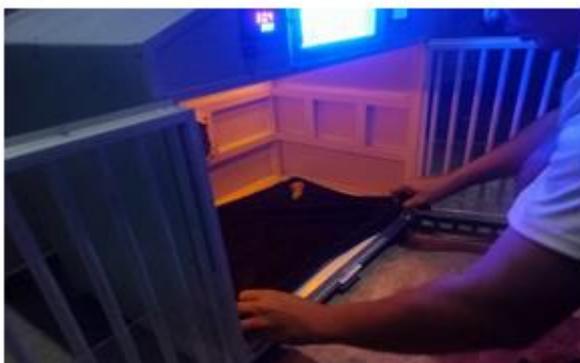
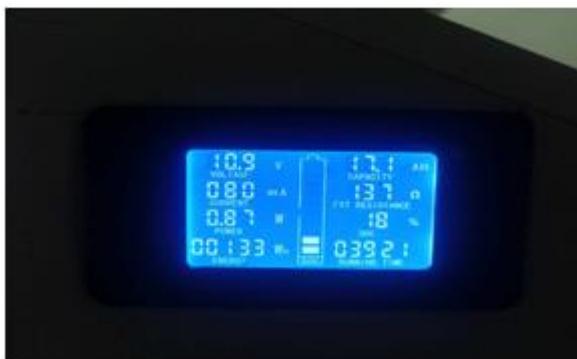
Watt meter: 11:9V  
 Start time: 1:01Pm-2:26Pm  
 Temperature: Exceed to 35.1°C  
 Watt meter Volt: 11.7V  
 Fan: 3 minutes



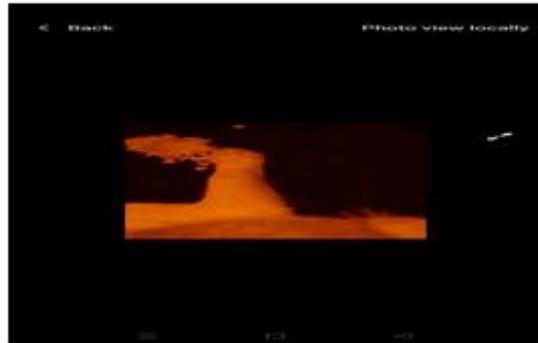
Watt meter: 11:7V  
 Start time: 2:27Pm-3:54Pm  
 Temperature: Exceed to 35.1°C  
 Watt meter Volt: 11.4V  
 Fan: 21 minutes



Watt meter: 11:4V  
Start time: 3:54Pm-6:37Pm  
Temperature: Exceed to 35.1°C  
Watt meter Volt: 11.9V  
Fan: 21 minutes



Time: 5:38Pm  
Dog pooped at 5:38Pm



Watt meter: 10:9V  
Start time: 6:37Pm-7:48Pm  
Temperature: Exceed to 35.1°C  
Watt meter Volt: 10.2V  
Fan: 21 seconds



Watt meter: 10:2V  
Start time: 6:37Pm-7:48Pm  
Temperature: 27.8°C

### Statistical Treatment

The researcher would utilize descriptive statistics, specifically utilizing the weighted mean, to interpret the results and gauge the efficiency, effectiveness, and functionality of the said box. This statistical approach allows for a nuanced analysis, assigning appropriate weights to different aspects of the data, providing a comprehensive understanding of the micro-controller-based carrier box performance. The weighted mean ensures that each factor's significance is duly considered, offering a robust and insightful interpretation of the evaluation outcomes.

### Scoring Procedures

The scoring procedure for evaluating IoT-enabled pet carriers assesses key aspects such as safety features, convenience features, the nature of pets' needs (including behavioral and physiological considerations), and overall usability. Each criterion is scored on a scale from 1 to 5, with sub-criteria

focusing on factors like environmental monitoring, real-time tracking, health monitoring, and comfort. The procedure provides a comprehensive evaluation of how well a pet carrier ensures safety, comfort, and convenience during transport, taking into account the pet's specific needs and the carrier's overall functionality and value.

## DEFINITION OF TERMS

To better understand, the following key terms in this study are operationally defined to avoid confusion in the interpretation of facts that are gathered and help the readers fully comprehend.

**IOT (Internet of Things).** Refers to a network of physical devices, vehicles, appliances, and other objects embedded with sensors, software, and connectivity, allowing them to collect and exchange data over the internet.

**Application.** Refers to a software program designed to perform specific tasks or functions on a device, such as a smartphone, tablet, or computer. Apps can range from games and social media platforms to productivity tools and utilities.

**Pet Carrier box.** Refers to is a portable enclosure designed to safely transport pets or small animals from one location to another.

**Transport.** Refers to the movement of people, goods, or animals from one place to another using various modes. It is essential for trade, communication, and travel.

**Safety.** Refers to the condition of being protected from harm, danger, or risks. It involves measures and practices.

**Convenience.** Refers to the quality of being easy, comfortable, and efficient, making tasks or activities simpler and less time-consuming.

## DEVELOPMENT OF IOT APPLICATION CARRIER BOX FOR PETS

This section presents detailed data and descriptions related to the design and fabrication process of the device. It outlines the steps undertaken to develop the device from concept to functional output, emphasizing the integration of various components and technologies to achieve the intended performance. The section also highlights the technical specifications, such as dimensions, materials used, power requirements, and electronic configurations. In addition, it discusses the key features of the device, including its smart functionalities, user interface, and embedded systems such as ventilation control, temperature sensors, and GPS tracking, all of which contribute to its innovative design and operational efficiency.

### Design

The design and fabrication of the IoT-enabled carrier box followed a step-by-step approach, starting with the conceptualization of its design as shown in part 1 figure 5, to address issues in traditional pet transport. This was followed by the careful selection of materials based on durability, weight, and functionality, as shown in part 2. The final phase as shown in part 3 involved the fabrication and integration of both mechanical and electronic components to create a fully functional prototype.

**Part 1. Design**

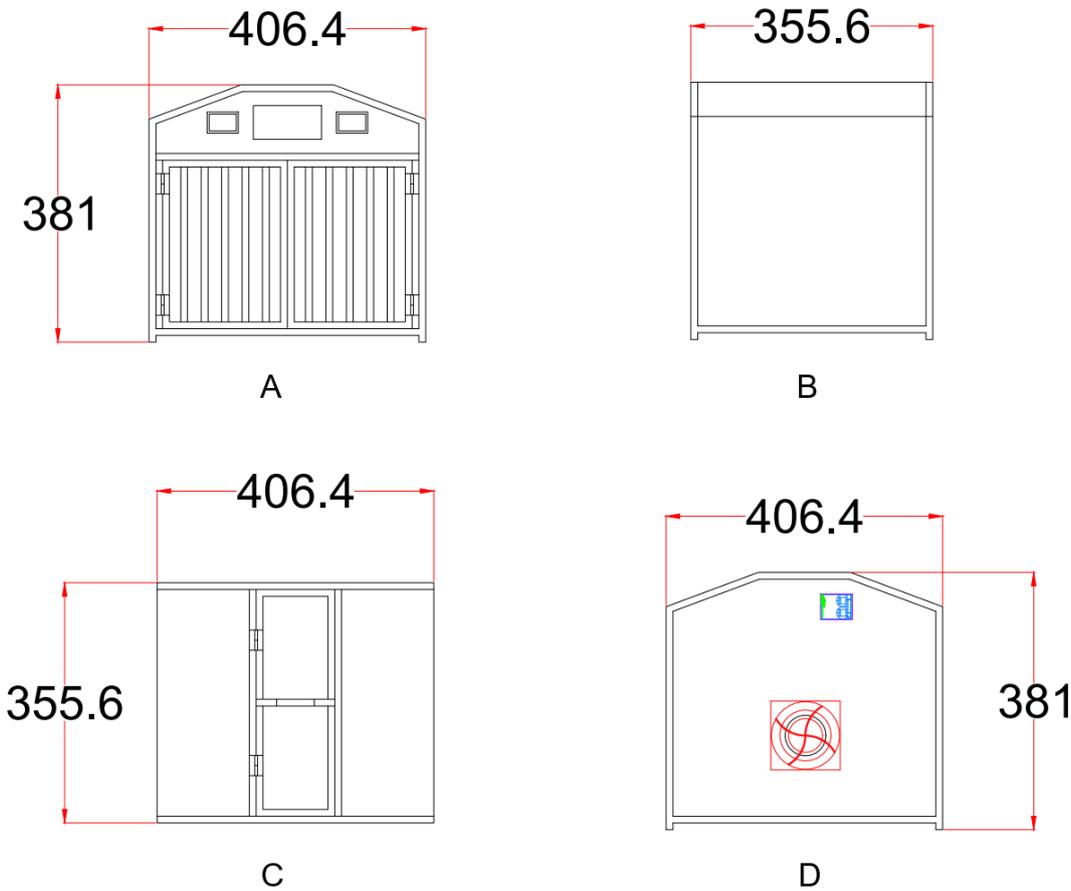


Figure 5. Technical drawing of IoT pet carrier. (A) Front view. (B) Side view. (C) Top view. (D) Back view

**Part 2. Selection of Materials**

In this part, the materials used for fabricating the body of the IoT-enabled carrier box were carefully selected based on factors such as strength, durability, weight, and suitability for housing electronic components. These materials were chosen to ensure the carrier provides structural stability, comfort for the pet, and protection for the internal systems during transport. The selection process is detailed in Table 2, highlighting the specific purpose of each material in the overall design.

Table 2.

*Materials for fabrication in Pet Carrier Box*

No.	Description/Specification	Quantity	Unit
1.	1x1 Square Tubes Aluminum	1 pc	4 meter
2.	½ Angular Aluminum	1pc	1 meter
3.	½ Aluminum Round Tubes	1pc	1.5 meter

4.	½ x1x1 Angular	1pc	1 meter
5.	3/8 Size Fiber Glass	1pc	.80 meter
6.	B Bolt Aluminum	2 pcs	1” inch
7.	J Clip Aluminum	1 pc	4.5 meter
8.	.01mm Size Stuco Aluminum	1 Pc	1.5 meter
9.	Sealant	1 pc	25 ml
10.	Ewire Aluminum	1 Pc	.60 meter
11.	Bracket Aluminum	4 Pc	2” inch
12.	Rivets	78 Pcs	1x1/8” inch
13.	Metal Cutting Disc	1 Pc	5x24.4 mm
14.	Electric Drill	1 Pc	288V
15.	Set Screw driver	1 Pc	6x5x7”
16.	Hinges	4 Pcs	1 ½” inch
17.	Measuring Tape	1 Pc	3 meter
18.	Riveter	1 Pc	10”x 2.4,3.2mm
19.	Pencil	1 Pc	7” inch
20.	Ruler	1 Pc	12” inch

Moreover, the electronic components, tools, and equipment required for the installation and operation of the IoT-enabled pet carrier box are presented in Table 3. These items were carefully selected to support the core functions of the device, including temperature monitoring, ventilation control, and GPS tracking. Each component plays a vital role in ensuring the efficient and reliable performance of the carrier during pet transport.

Table 3.

Materials, Equipment and Internet of thing Installation in Carrier box for Pet

No.	Description/Specification	Quantity	Unit
1.	DC Boost Converter Boost Power Module	1 pc	1800W 40A
2.	W3230 mini digital temperature controller 12V	1pc	DC 12/24V AC 110 – 220V W3230

3.	100A lead acid Battery charger	1pc	YL30A 6 -60V 30A
4.	PWM Power motor speed Controller	1pc	DC 12 – 40V 12V 10A
5.	Low Voltage Disconnect Switch Cut Off 12V	1pc	M609 12V
6.	HD Wireless Camera Security Monitor for Home Day/Night Version video	1 pc	A9 1080p
7.	50A DC Digital Meter Display	1 Pc	PZEM – 015 50A
8.	Voltage protector lighting	1 pc	MPL x1-230-W-L
9.	Over under voltage protector breaker	1 Pc	40A-60A
10.	Solid state Relay	1 Pc	DC 12V
11.	Ats Circuit Breaker	1 Pc	40A DC 12V
12.	Adjustable volt. overvoltage and current	1 Pc	DC 12.6V-13.8V
13.	Automatic photo cell switch	1 Pc	AS-10 220V 12V 10A
14.	Battery management system	1 Pc	12V/24V
15.	Timer Switch	P c	DC 12V/16A
16.	Tracker Device	1 Pc	GSM GPRS 2024 5g
17.	Sea Metal Absorbent Fabric	2 Pcs	40x60”
18.	Bamboo Charcoal Odor Remover	10 Pc	3x60 grams
19.	Roll Soldering lead	1 Pc	6 meters
20.	Hand Gloves	1 pear	800 grams
21.	Electric Drill	1 Pc	288V
22.	Drill Bits (Metal)	2 Pc	1/8 x3” inch
23.	Shunt	1 Pc	½ x 3” inch
24.	Soldering Iron	1 Pc	220V
25.	Plywood	1 Pc	½ x 6” inch
26.	Fan	1 Pc	DC 12V 0.18A

27.	LCD Digital Multi Tester	1 Pc	200mV/2V/20V/200V
28.	Electrical Wire	1 Roll	1.5 meter
29.	Fan	1 Pc	12V DC 0.1A
30.	Tracker Device	1Pc	GSM GPRS 24 5g

### Part 3. Fabrication procedure in carrier box for pets

The fabrication procedure in developing the IoT-enabled pet carrier device involved several systematic steps to ensure accuracy and functionality.

Figure 6 shows the preparation of all the tools, equipment, and materials needed to build the pet carrier box. This step is important to make sure everything is ready before the actual work begins. It includes checking that the right materials are on hand and setting up the tools properly. Once prepared, the materials are measured carefully to match the planned size of the carrier.



Figure 6. Materials need for Design and fabrication



Figure 7. Measuring the desired height, length and width, of carrier Box for pet.

The height, length, and width are based on what's comfortable and safe for the pet. Figure 7 then shows the cutting of these materials according to those measurements, which is a key step before putting everything together.

Figure 8 shows the installation of the exhaust fan and door hinges, which are important features to ensure proper ventilation and ease of access for the pet. The exhaust fan helps maintain airflow inside the carrier, keeping the pet comfortable during use. Meanwhile, the door hinges are securely attached to allow smooth opening and closing of the door.



Figure 8. Installation of Exhaust fan and Door Hinges.



Figure 9. complete assemble of carrier box for pet Floor screen and Drawer

Following this step, Figure 9 highlights the fully assembled floor screen and a pull-out drawer for the pet carrier box. The floor screen provides a clean and elevated surface for the pet, while the drawer offers extra space for storing pet essentials. These final touches make the carrier more functional, comfortable, and convenient for both the pet and the owner.



Figure 10. Complete fabrication of carrier Box for Pet.

Figure 10 shows the fully fabricated pet carrier box, highlighting the final product after all components have been carefully measured, cut, assembled, and installed. Each part was crafted with attention to detail to ensure the carrier is both durable and reliable. With its thoughtful design and sturdy construction, the carrier is now ready for use, providing a safe, comfortable, and convenient space for transporting or housing a pet.

Moreover, the necessary electronic components shown in Figure 11 were prepared and carefully connected to ensure proper functionality. This included assembling a battery setup consisting of four 3.7V cells connected in series to produce a 12V 10A output, as illustrated in Figure 12. In addition, the device's smart features such as the temperature sensor, A9 mini camera, and GPS tracking module were thoughtfully installed and securely integrated into the pet carrier box. These components work together to enhance the safety, monitoring, and convenience of the carrier for both the pet and the owner.



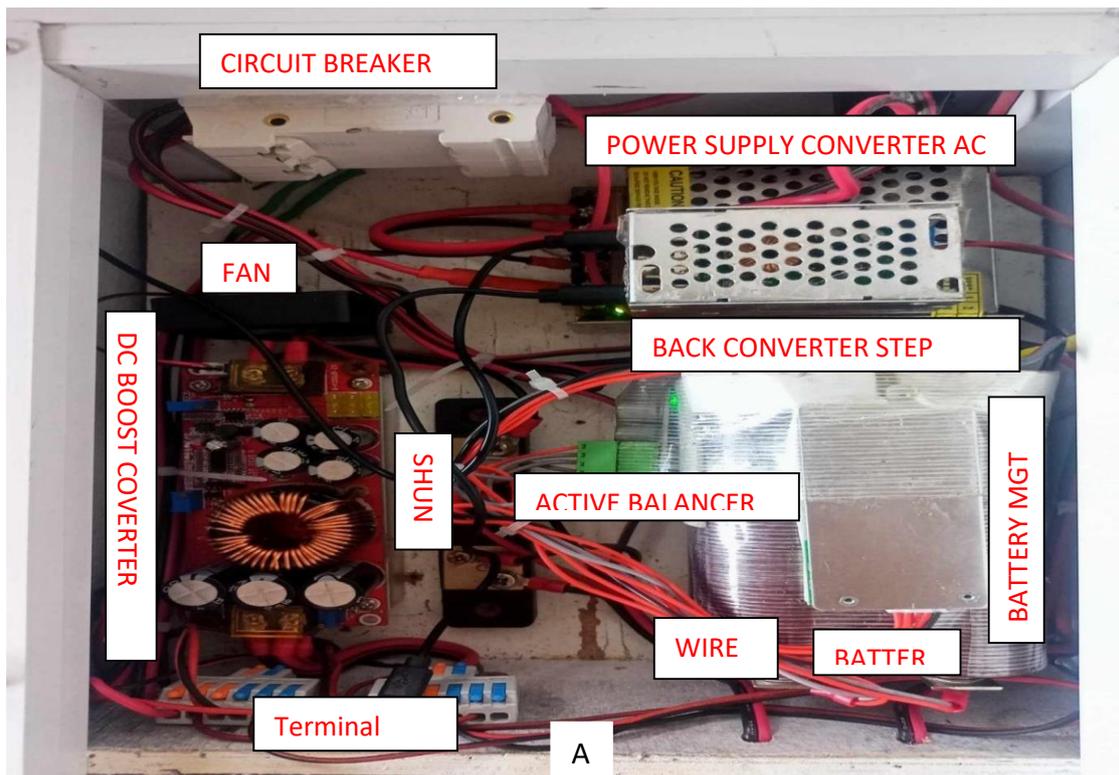
Figure 11. Materials needed for the Pet Carrier Box



Figure 12. Assemble a Battery 12V 10A 3.7V/ 4 pcs in series connection



Figure 13. Assemble the materials, including the battery (12V, 10A), a temperature sensor, and A9 1080p mini camera.



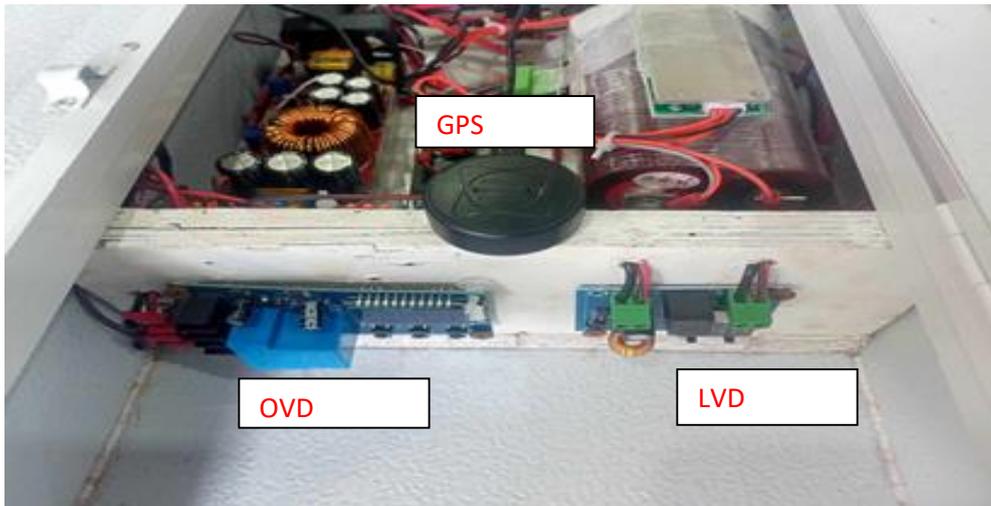


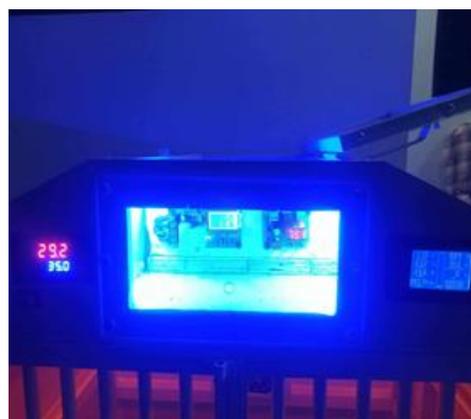
Figure 14A show the fully assembled electronic system

Figure 14. (A) Connected electronic components of the device. (B) connection of GPS, OVD, and LVD

of the IoT-enabled pet carrier, featuring carefully connected components that ensure functionality and efficiency. Key power management modules include a circuit breaker, power supply converter (AC to DC), buck and boost converters, battery with active balancer, and battery management system (BMS) to regulate voltage and protect the battery. The GPS module enables real-time tracking, while the fan and sensors work together to maintain proper ventilation and temperature, all controlled by an Arduino-based setup. Additional components like the terminal block, SHU, LVD (Low Voltage Disconnect), and OVD (Over Voltage Disconnect) ensure safe and stable operation of the system under various conditions as presented in figure 14B.



A



B

Figure 15. Monitor of pet carrier box. (A) LCD monitor for voltage. (B) Front side of a Pet Carrier Box with LCD Monitor Reading

Figure 15 highlights the monitoring feature of the pet carrier box designed to help users easily keep track of the device’s power status. In Figure 15A, an LCD monitor is shown, which displays the voltage level of the battery, allowing for quick and convenient power monitoring. This helps ensure that the smart features of the carrier like the camera, sensors, and fan have enough power to operate properly. Figure 15B shows the LCD monitor installed on the front side of the pet carrier box, making it easily visible and accessible. This thoughtful placement adds to the overall user-friendliness of the design. With this feature, pet owners can confidently check the system’s status at a glance.

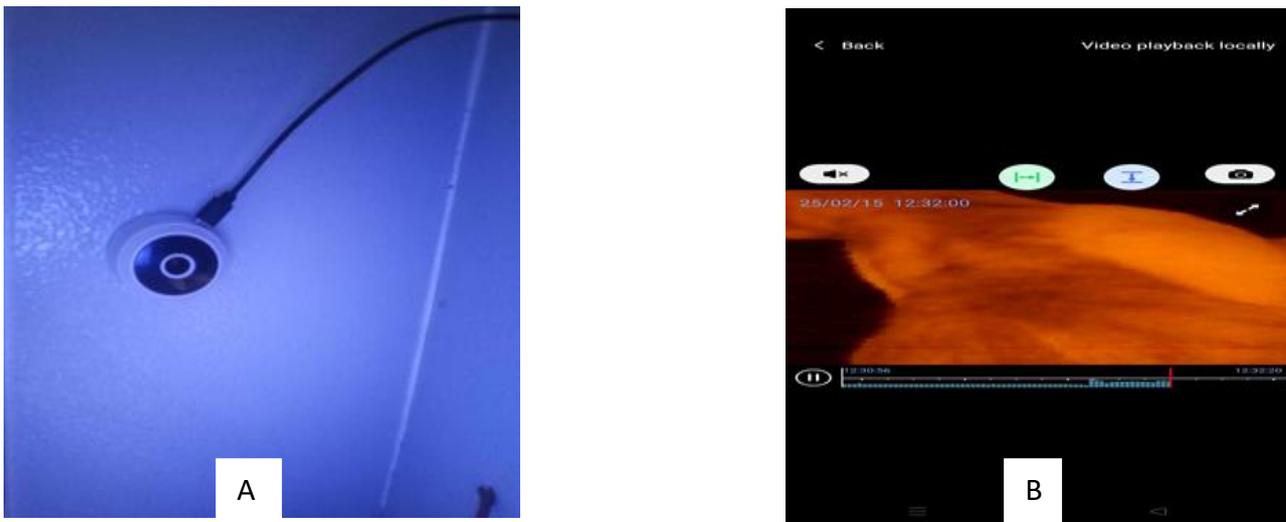


Figure 16. Camera of pet carrier box (A) Mini Camera A9. (B) Cellphone monitor for playback and monitoring of pet.

The camera feature of the pet carrier box, which allows owners to keep an eye on their pets even from a distance was shown Figure 16. In Figure 16A, the A9 mini camera is shown securely installed inside the carrier, positioned to provide a clear view of the pet’s space. This camera captures real-time footage, offering both safety and peace of mind. Figure 16B shows how the footage can be viewed through a cellphone, making it easy for users to monitor their pets anytime, anywhere. The setup also allows for playback, so owners can check in on their pet’s activity even if they miss it in the moment. This feature adds a smart layer of convenience and care to the pet carrier box.

Additionally, Figure 17 features the 12V exhaust fan, which helps maintain proper ventilation inside the carrier, ensuring the pet remains cool and comfortable during travel or use.



Figure 17. Exhaust Fan 12V

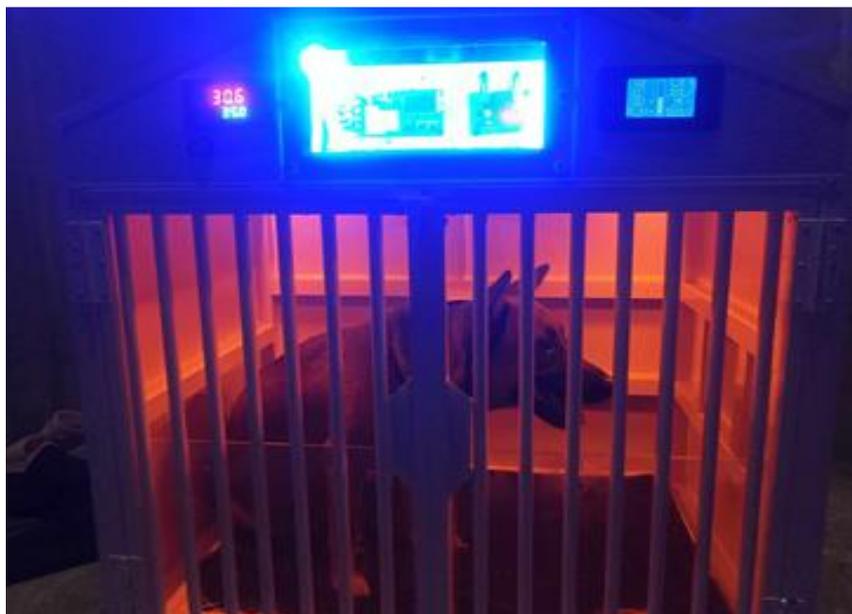


Figure 18. Overall functionality in Pet Carrier Box for Testing

Figure 18 presents the fully assembled and functional IoT-enabled pet carrier device, showcasing the integration of all mechanical and electronic components. This final output reflects the successful implementation of the design, material selection, and fabrication processes. The device is now capable of performing its intended functions, including automated ventilation, temperature monitoring, and GPS tracking as shown in figure 19, ensuring both safety and comfort for pets during transport.

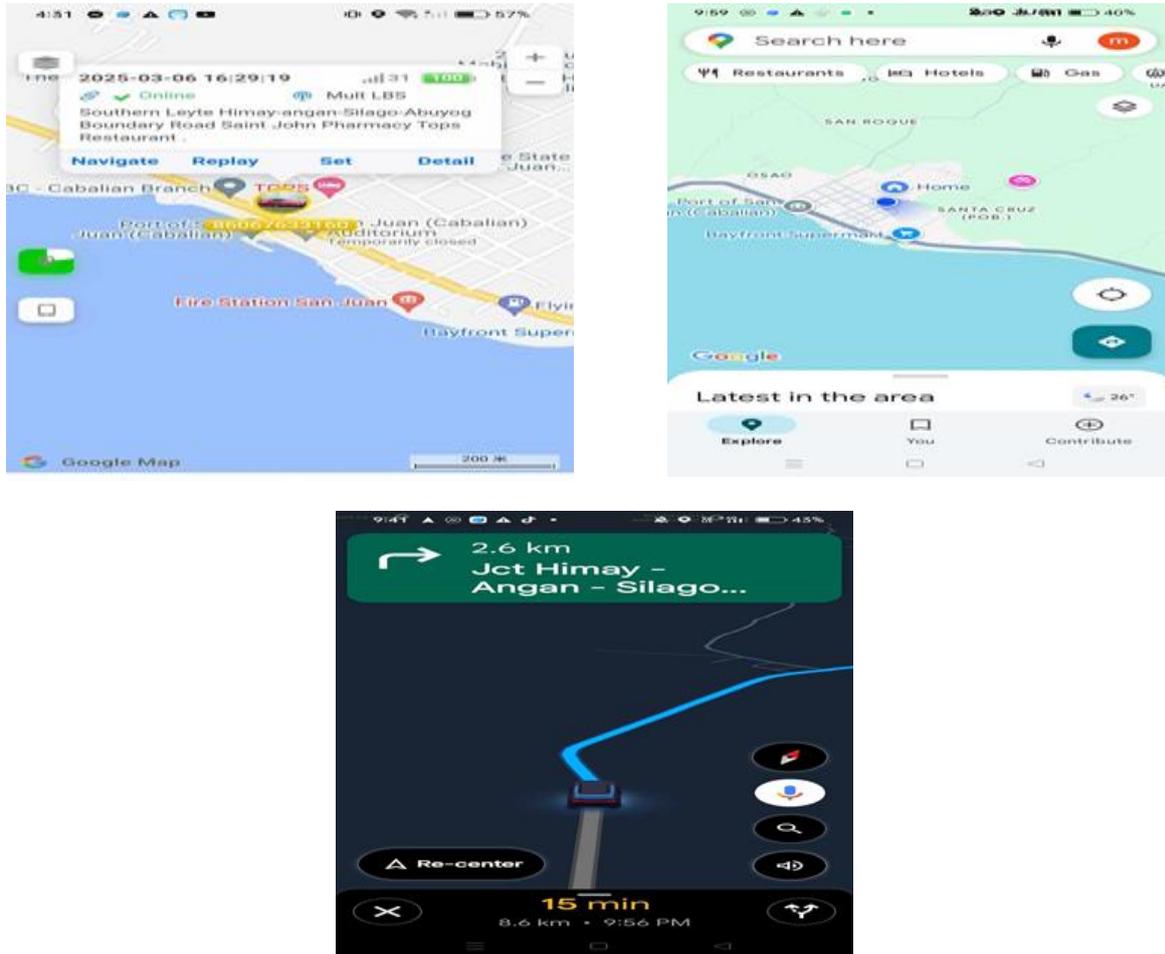


Figure 19. Screen shot of GPS tracker Device before and after the carrier box for pets is in travel

**Features**

The aspects of the IoT application pet carrier box in figure 20 emphasize an owner-focused design prioritizing pet comfort and convenience to the owner. As shown in table 4, the portable and durable design composed of a Stucco shell and aluminum-framed screen makes the box lightweight at 5.5 kg while strong enough for withstanding handling when being moved around. This is especially advantageous for pet owners who travel extensively or require a secure carrier in the case of vet visits or activities outdoors.

Its large interior (60 cm x 50 cm x 40 cm) provides sufficient space for small to mid-size animals, alleviating stress and giving the animal room to move or rest easily. Coupled with its cord-free operation on a 12V 10Ah rechargeable battery, the carrier accommodates prolonged outdoor or mobile applications without being hampered by continuous access to power outlets. Its autonomy is particularly beneficial in travel or exigency situations.

*Table 4*

*Features of the IoT Application Carrier Box*

<b>Feature</b>	<b>Description</b>
<b>Portable and Durable Design</b>	Built with a Stucco shell and aluminum-framed screen; lightweight (5.5 kg) for easy transport.
<b>Spacious Interior</b>	Dimensions of 60 cm x 50 cm x 40 cm provide enough room for small to medium-sized pets.
<b>Cordless Operation</b>	Powered by a rechargeable lithium-ion battery (12V 10Ah) for mobility and outdoor use.
<b>Smart Ventilation System</b>	Includes a 12V 0.18A fan controlled by temperature sensors for automatic cooling.
<b>Real-Time Temperature Monitoring</b>	Integrated digital display with $\pm 29^{\circ}\text{C}$ accuracy to ensure a safe internal environment.
<b>Remote Monitoring Capability</b>	Equipped with an A9 mini night-vision camera that connects to a mobile app for live pet surveillance.
<b>Automatic Safety Response</b>	Fan activates only when temperature exceeds $35^{\circ}\text{C}$ , helping conserve power while maintaining comfort.

The intelligent ventilation system, comprising a 12V 0.18A fan controlled by temperature sensors, guarantees air circulation automatically when the internal temperature is above  $35^{\circ}\text{C}$ . This automatic adjustment shields pets from heat stress or discomfort, making the system ideal for application in tropical or hot climates. The real-time monitoring of temperature, presented on a digital display with  $\pm 29^{\circ}\text{C}$  accuracy, equips users with the ability to remain aware of internal conditions and make prompt decisions when necessary.



*Figure 20. IOT application carrier box*

In addition, the remote monitoring feature through an A9 mini night-vision camera and mobile app enables pet owners to monitor their pets remotely. This adds security and peace of mind, particularly for pet owners who leave their pets temporarily unattended. Finally, the automatic safety response, wherein the fan operates only when needed, not only keeps the pet safe but also saves battery power-enabling longer use without constant recharging.

Basically, they suggest a balanced, useful, and intelligent solution for pet transportation and care, especially beneficial in applications that need mobility, remote control, and environmental protection management.

### ***Specification***

The IoT application pet carrier box technical specifications in table 5 focus on stable performance with an inbuilt power and control system. Its 12V 10Ah rechargeable lithium-ion battery has a maximum support of 11.5 hours, providing constant use during extended travel or in off-grid situations. The presence of a low-voltage disconnect functionality guards the system from over-

Table 5.

*Technical Specifications of the IoT Application Carrier Box*

Specification	Details
<b>Material</b>	Stuco shell with aluminum-framed screen
<b>Dimensions</b>	60 cm (L) × 50 cm (W) × 40 cm (H)
<b>Weight</b>	5.5 kg
<b>Battery</b>	Rechargeable lithium-ion battery, 12V 10Ah (composed of four 3.7V cells)
<b>Ventilation System</b>	Single 12V 0.18A fan, temperature sensor-controlled
<b>Temperature Display</b>	Real-time monitoring with ±29°C accuracy
<b>Camera</b>	A9 mini night-vision camera with mobile app connectivity
<b>GPS Tracking</b>	Integrated GPS module for real-time location tracking via mobile app
<b>Operational Duration</b>	Up to 11.5 hours (based on battery performance during test)
<b>Control System</b>	IoT-based automation with temperature-triggered fan activation

discharge, thus ensuring battery life and device protection. The 0.18A, 12V temperature-controlled fan runs only when necessary, optimizing power efficiency and successful cooling. Coupled with an accurate real-time display of temperature (±29°C), the system provides precise thermal control during the day.

Furthermore, the carrier box includes intelligent connectivity features like a GPS module and A9 night-vision camera connected to a mobile app. Such features augment the functionality of the device from mere passive transport to real-time tracking and remote monitoring of the pet—a critical plus for security-minded consumers. Overall, the requirements suggest a well-tuned system that provides reliable performance, environmental sensitivity, and mobile management, which is suitable for contemporary pet care in dynamic or long-term-use applications.

*Evaluation of Design, Specification, and Features*

The pet carrier box device was given a very positive evaluation (table 5), with a total weighted mean of 4.61, which falls under the category of Excellent. The most prominent feature was the comfort offered to pets, which was rated highest at 4.76. The result indicates that pet owners are concerned with a design that keeps their pets safe and healthy. The lowest score, although still Excellent, was awarded to the product specification clarity (4.36), showing room for improvement in how the product information is relayed to the consumers.

The high rank of the favorable evaluation outcome signifies that the Internet of things carrier box for pets is good and possesses consumers' desired features. However, efforts should be further extended toward product specification explanations to facilitate proper understanding by users. This may be done through the provision of lengthy user guides, video demonstrations, or interactive tutorials to facilitate a proper understanding of product features.

*Table 6.*  
*Evaluating design, specification, features*

S/N	Indicators	Weighted Mean	Verbal Description
1.	How would you rate the design of the Internet of thing carrier box for pets?	4.52	Excellent
2.	Is the size and shape of carrier box is suitable for your pets?	4.68	Excellent
3.	How clear and easy to understand are the specifications of the carrier box for pets?	4.36	Excellent
4.	How do you rate the features (e.g., temperature control, GPS) in the carrier box for pets?	4.72	Excellent
5.	How you think the design of the carrier box for pet provides enough comfort for your pet?	4.76	Excellent
<b>Aggregate Weighted Mean</b>		<b>4.61</b>	<b>Excellent</b>

*Legend: 4.21-5.00- Excellent; 3.41-4.20-Good; 2.61-3.40-Neutral; 1.81- 2.60-Poor; 1.00-1.80-Very Poor*

### **FUNCTIONALITY OF THE IOT BASED PET CARRIER BOX (OPTIMAL INTERNAL TEMPERATURE AND AIR CIRCULATION, AND ENERGY EFFICIENCY.**

This section presents the performance evaluation of the pet carrier box in terms of maintaining optimal internal temperature and proper air circulation, as well as its energy efficiency. It highlights how the device regulates temperature through its automated ventilation system and assesses the power consumption during operation.

#### ***Optimal internal temperature and air circulation***

Table 7 presented the data for the efficiency of the pet carrier box. The Internet of thing carrier box for pet was charged for up to 7.5 hours from a low voltage of 10.2 V. It reached its maximum voltage of 13.1 V. The experiment started around 8:00 am on a sunny day with a dog that serves as the pet inside the pet carrier to be experimented. The battery capacity is 12V 10Ah. The PZEM provided all the electrical data parameters—015 (50A Shunt) DC Digital Meter, as shown in the table below, and some of the data, like the running time, were calculated.

There was a big jump in current and power readings at exactly 9:45 a.m. when the temperature reached above the limit of 35 °C. This time, the exhaust fan was running to cool the temperature. Some of the data provided by the PZEM was tabulated in the table; the highest temperature reading within the time (hourly) in °C was also observed, which signifies that the fan was running in that period. The remaining battery voltage (V) was also shown together with SOC %, which is a measure of how much energy is left in a battery relative to its full capacity and is expressed as a percentage, with 100% representing a fully

charged battery and 0% representing a fully discharged battery. The voltage and SOC declined as time passed. The current (A) and power (W) readings were observed during the observation period, showing how much current and power was used. Even if the fan is not running or other peripherals are not running, such as the camera, GPS tracker there would still be energy consumption for other electronic accessories, such as the display and memory. The total operation time reached 11 hours and 30 minutes until the low voltage level of 10.2V was reached from a full battery charge of 13.1V.

### *Energy Efficiency*

The efficiency of the IoT-pet carrier box in energy terms can be gauged on the basis of how power consumption interacts with battery life and cooling fan on-time intervals during the day as illustrated in Table 7. The system proved

**Table 7.**

Data of an IoT application carrier box for pets

Time	Inside the Carrier Highest Temperature Hourly Reading (°C)	Battery Voltage (V)	Current (A)	Power (W)	Running Time (Hrs.)	SOC (%)	Remarks
8:00 am	29.9	13.1	69 mA	.90	0	69	The fan turns on for 31 seconds after the temperature reaches 35.3 °C between 8:00 to 9:45 am.
9:45 am	35.4	12.7	1.57	19.9	1.25	59	The fan turns on for 4 minutes after the temperature reaches 35.4 °C between 9:45 to 10:23 am.
10:23 am	35.2	12.5	.70 mA	.70	1.88	57	The fan turns on for 3 minutes when the temperature reaches 35.1°C between 10:23 and 11:10 am.
11:10 am	35.4	12.4	71 mA	.88	2.66	53	The fan turns on for 4 minutes after the temperature reaches 35.3 °C between 10:23 to 11:10 am.
12:04 pm	35.3	12.2	75 mA	.91	3.54	48	The fan turns on in 3 minutes when temp. reaches 3.1°C between 11:10 am to 12:04 pm
1:02 pm	35.3	11.9	76 mA	.90	4.51	40	The fan turns on in 3 minutes when the temperature reaches

							35.1 °C between 1:02 to 2:27 pm.
2:27 pm	30.1	11.7	75 mA	.87	5.94	36	The fan turns on in 21 seconds after the temperature reaches 35.1 °C between 2:27 to 3:54 pm.
3:55 pm	30.1	11.4	76 mA	.87	7.39	30	The fan turns on in 21 seconds after the temperature reaches 35.1 °C between 3:55 to 6:38 pm.
6:38 pm	30.1	10.9	80 mA	.87	10.11	18	The fan turns on in 25 seconds after the temperature reaches 35.1 °C between 6:38 to 7:48 pm.
7:48 pm	27.8	10.2	1.8 mA	18.4	11.29	0	The battery reached the low voltage disconnect level of 10.2 V, at which point all electrical components were automatically turned off.

to be energy conservative in its operation, turning on the cooling fan only when the temperature inside reached 35 °C. This threshold-based on-time optimization resulted in reducing unnecessary power draw. Between 8:00 am and 7:48 pm, the fan was activated periodically for brief intervals, from 21 seconds to 4 minutes, thus controlling internal temperature while not maintaining high current consumption. Of note, the present draw did not exceed 100 mA throughout most operations with an associated power consumption of less than 1 W, apart from a single spike at 9:45 am and a repeat spike at 7:48 pm, which may be indicative of transient high-power spikes perhaps due to enhanced fan speed or motor starting load.

In spite of these surges, the steady dropping of battery voltage and state of charge (SOC) from 69% to 0% in about 11.29 hours indicates a steady but effective power consumption. The system kept running round the clock without any human intervention, switching and switching off the cooling system as required. But by 7:48 pm, the voltage had fallen to 10.2 V and activated the system's low voltage disconnect to prevent the battery from being over-discharged. This shutdown means that although the system efficiently regulates power, the present battery capacity is likely to only last about 11 hours under

fairly high ambient conditions before charging needs to be resumed. In general, the results highlight the system's real-world energy efficiency, with implications for battery size optimization or the addition of solar charging for extended unattended operation in practical applications.

**Stress Reduction**

The pet carrier box was Very Effective on all indicators, with a weighted mean of 4.57 (Table 8). The temperature control scored the highest with a 4.8 rating, pointing out the efficacy of delivering the optimal environment for the pets. Suitable air circulation (4.74) and safeguarding in transport (4.48) also scored high, confirming the ability of the carrier to guarantee pet safety.

**Table 8**

Evaluating Effectiveness of the Pet Carrier Box

S/N	Indicators	Weighted Mean	SD	Verbal Description
1.	How effective is the pet carrier box in maintaining the temperature for your pet?	4.8	0.45	Very Effective
2.	How well does the pet carrier box ensure proper air circulation?	4.74	0.53	Very Effective
3.	How effective is the pet carrier box in reducing stress for your pet during travel?	4.38	0.70	Very Effective
4.	How secure do you feel the pet carrier box is in terms of safety mechanisms (e.g., locks, moist detection)?	4.46	0.76	Very Effective
5.	How effective do you think the pet carrier box is at protecting your pet during transportation?	4.48	0.65	Very Effective
<b>Aggregate Weighted Mean</b>		<b>4.57</b>	<b>0.62</b>	<b>Very Effective</b>

**Legend:** 4.21-5.00- Very Effective; 3.41-4.20- Effective; 2.61-3.40-Somewhat Effective; 1.81- 2.60-Not Effective; 1.00-1.80-Completely Ineffective

Temperature control was rated as the highest, with a rating of 4.8, highlighting the effectiveness in providing an optimal environment for the pets. Proper air circulation (4.74) and protection during transport (4.48) were also highly rated, affirming the carrier's capability to ensure pet safety. However, the lowest rating (4.38) was given to stress reduction for pets during travel, suggesting that while the carrier performs well, enhancements such as noise insulation, vibration reduction, or stress-relieving mechanisms may be beneficial. The high rating show that the pet carrier offers a secure and stable environment for pet transportation. However, pet stress remains an area of concern. Future modifications may incorporate calming features such as soothing sounds, ergonomic padding, or enhanced ventilation systems to improve the overall pet experience.

**EVALUATION OF THE CARRIER BOX FOR PETS**

This section evaluates the IoT Application Pet Carrier Box based on ease of use, safety, and user satisfaction. Key features such as temperature control, ventilation, GPS tracking, and real-time monitoring were tested under simulated travel conditions. User feedback highlighted the carrier’s convenience, effective safety measures, and enhanced confidence in monitoring pets during travel.

**Ease of use**

**Table 9**

Evaluating the Functionality of the Pet Carrier Box

S/N	Indicators	Weighted Mean	SD	Verbal Description
1.	How easy is it to use the pet carrier box (e.g., setup, handling)?	4.5	0.76	Very Easy
2.	How useful do you find the features of the pet carrier box for travel purposes (e.g., temperature control, tracking)?	4.76	0.59	Very Easy
3.	How would you rate the reliability of the pet carrier box (e.g., consistent performance, durability)?	4.64	0.53	Very Easy
4.	How easy is it to maintain the pet carrier box (e.g., cleaning, troubleshooting)?	4.5	0.74	Very Easy
5.	How does the pet carrier box meet your overall expectations for safety and comfort during transport?	4.72	0.50	Very Easy
<b>Aggregate Weighted Mean</b>		<b>4.62</b>	<b>0.624</b>	<b>Very Easy</b>

**Legend:** 4.21-5.00- Very easy; 3.41-4.20- Easy; 2.61-3.40-Somewhat Easy; 1.81- 2.60-Difficult; 1.00-1.80-Very Difficult

The functionality of the pet carrier, as indicated in table 9, was rated as Very Easy, with a total weighted mean of 4.62. The most highly rated by the participants and users was travel-related functionality (4.76), which indicates the importance of advanced functionalities such as temperature control and GPS tracking. While all features were highly rated, ease of maintenance was rated slightly lower (4.5), suggesting that some users may find cleaning or troubleshooting more complex than expected. The findings shows that users rate the pet carrier as being very functional and easy to use. Yet, maintenance features such as self-cleaning material, ease of disassembly for cleaning, or simpler maintenance instructions would improve usability even more.

**Safety**

As presented in Table 10 the safety evaluation yielded a Strongly Agree rating, with an aggregate weighted mean of 4.62. Safety testing was the most

**Table 10.**

Evaluating the Safety of Internet of things Carrier Box for pets

S/N	Indicators	Weighted Mean	Verbal Description
1.	The Internet of Thing carrier box for pets comply with relevant safety standards and regulations.	4.6	Strongly Agree
2.	The carrier box for pets undergone safety testing.	4.82	Strongly Agree
3.	The carrier box for pets used safe for the user and environment.	4.64	Strongly Agree
4.	There are clear and accessible safety instructions provided with the carrier box.	4.44	Strongly Agree
5.	Is your carrier box for pets secure and comfortable for safe travel?	4.6	Strongly Agree
<b>Aggregate Weighted Mean</b>		<b>4.62</b>	<b>Strongly Agree</b>

**Legend:** 4.21-5.00- Strongly Agree; 3.41-4.20- Agree; 2.61-3.40-Neutral; 1.81-2.60-Disagree; 1.00-1.80-Strongly Disagree

highly rated indicator (4.82), reflecting very high confidence in the product's regulatory safety compliance. Clarity of safety instructions, however, was rated a little lower (4.44), suggesting more detailed safety instructions to help users ensure correct usage.

The high ratings validate that the carrier box for pets is a safe and trusted choice for pet owners. Further, increasing the accessibility and comprehensiveness of safety instructions via interactive user manuals, video guides, or graphical infographics could increase user confidence and ensure correct handling.

### User Satisfaction

**Table 11.**

Evaluating the Overall Evaluation

S/N	Indicators	Weighted Mean	Verbal Description
1.	How satisfied are you with the overall design of the carrier box for pets?	4.8	Very Satisfied
2.	How satisfied are you with the overall functionality of the carrier box for pets?	4.82	Very Satisfied
3.	Would you recommend this Internet of thing carrier box for pets to other pet owners?	4.46	Very Satisfied

4.	How likely are you to continue using the Internet of thing carrier box for Pets future trips?	4.5	Very Satisfied
5	Are you satisfied with the carrier box for pets compare to other pet carriers you have used in terms of comfort and convenience?	4.5	Very Satisfied
<b>Aggregate Weighted Mean</b>		<b>4.62</b>	<b>Very Satisfied</b>

**Legend:** 4.21-5.00- Very Satisfied; 3.41-4.20- Satisfied; 2.61-3.40-Neutral; 1.81- 2.60-Dissatisfied; 1.00-1.80- Very Dissatisfied

The overall score resulted in a Very Satisfied rating with a total weighted average of 4.62 as shown in table 11. The highest (4.82) was for the functionality of the pet carrier, which confirmed its simplicity and effectiveness by the participants. The lowest (4.46) was for user referrals, which, although high, reflects that a fraction of users may have some hesitation in recommending the product.

The result shows that the pet carrier with Internet of thing is highly acceptable, with high satisfaction with design, performance, and safety by users. Its market potential is emphasized by its high level of satisfaction, and addressing small problems like pet stress handling and ease of maintenance may increase its consumer acceptability and extend its acceptance by pet owners.

The result shows that the pet carrier with Internet of thing is highly acceptable, with high satisfaction with design, performance, and safety by users. Its market potential is emphasized by its high level of satisfaction, and addressing small problems like pet stress handling and ease of maintenance may increase its consumer acceptability and extend its acceptance by pet owners.

## **FINDINGS, CONCLUSION AND RECOMMENDATIONS**

### **FINDINGS**

The research evaluated the design, efficiency, safety, and satisfaction of a user for an IoT application pet carrier box. The pet carrier box was constructed with Stucco shell material for strength and an aluminum-framed screen for portability at 5.5 kg, with enough space for small to medium-sized pets. Its components are a rechargeable lithium-ion battery, a temperature sensor-controlled fan in its ventilation system, and a real-time display of temperature for monitoring the pet's environment to ensure the best conditions. Moreover, the carrier comes with an A9 mini night-vision camera with connectivity through a mobile app and GPS for monitoring pets remotely. The design, specification, and feature evaluation provided an Excellent rating (4.61 weighted mean), with the highest rating for pet comfort (4.76) and the lowest for product specification clarity (4.36), suggesting the importance of improved consumer information.

In efficiency, temperature was constant at equal or up to 35.1°C and 35.4°C, but battery drain was experienced, corresponding with fan run times. Voltage decreases were not the same, implying that extended usage of the cooling system may contribute to quicker draining of the battery. The carrier's effectiveness in pet safety and stress relief was scored Very Effective (4.57 weighted mean), with temperature adjustment (4.8) and airflow (4.74) scoring the highest. Stress relief for pets when traveling,

though, scored the lowest (4.38), and some added features like noise damping, vibration damping, or calming systems could actually make pets better off.

The ease of use and functionality were Very Easy (4.62 weighted mean), and travel-related functions (4.76) were marked highest, affirming that features of the carrier, temperature control and tracking, were liked by users. The ease of maintenance was a notch lower at 4.5, indicating that easier cleaning procedures or troubleshooting steps could enhance user experience. The safety assessment revealed Strong Agreement (4.62 weighted mean), and the highest rated was safety testing (4.82), reaffirming user trust in its safety and compliance with regulations. Clarity of safety instructions (4.44) was, however, slightly lower, revealing the necessity for easier and clearer safety guidelines. The user satisfaction assessment yielded a Very Satisfied rating (4.62 weighted mean), and functionality (4.82) was the highest rated. User referrals received the lowest rating (4.46) and indicate that although the product is popular, fixing minor issues of usability may make it more attractive to consumers in the marketplace.

## CONCLUSION

This study demonstrates that the IoT pet carrier is a smart and reliable solution to the common problems associated with traditional pet transportation. It specifically addresses issues such as temperature control, ventilation, and real-time monitoring. By successfully combining durability, ventilation for temperature control, and live tracking, the carrier addresses key gaps in existing designs, promoting both pet safety and owner peace of mind. The pet carrier received high evaluation ratings for design, functionality, and safety, confirming its usability. However, there is still room for improvement. Enhancing battery life, adding features that reduce noise and stress, and making it easier to maintain can increase its appeal in the future. Overall, the results suggest that IoT technology has significant potential in pet care, offering smarter and more responsive solutions that prioritize animal welfare and travel comfort.

## RECOMMENDATION

Based on the conclusions of this study, several areas for future research and product development can be explored.

1. It is recommended to enhance battery capacity, integrate energy-efficient cooling systems, and explore alternative power sources like solar panels or kinetic energy harvesting to extend operational hours.
2. Research should focus on noise insulation, vibration-dampening technology, and calming mechanisms such as white noise, aromatherapy, or ergonomic padding to minimize pet anxiety during transport.
3. Biometric pet monitoring, AI-powered behavior analysis, and automated hydration systems can further improve pet welfare and owner convenience.

## Output of the Study

The application of Internet of Things (IoT) technology in pet transportation is a major innovation in ensuring pet safety, comfort, and tracking during transportation. The IoT Application Pet Carrier Box was designed as an intelligent transport system that solves major issues in conventional pet carriers,

including temperature control, ventilation, and remote tracking. Through the use of real-time environmental monitoring and IoT mechanisms, this pet carrier improves pet welfare and owner convenience.

The pet carrier was built with a long-lasting Stucco shell and an aluminum-framed screen, the IoT pet carrier is a balance of strength and lightness, tipping the scales at 5.5 kg. Measuring 60cm x 50cm x 40cm, it offers sufficient room for small to medium-sized pets, making it ideal for all kinds of transport needs such as flying, road transportation, and visits to the vet. The source of power is a rechargeable lithium-ion battery (12V 10A, 3.7V, 4 pcs), which enables cordless use and prolonged use without reliance on external power.

One of the key innovations of this carrier is its air circulation system, which includes one fan regulated by temperature sensors for effective air flow, minimizing the risks of overheating or improper ventilation. Moreover, the A9 mini night-vision camera with mobile app connectivity lets owners view and monitor their pets remotely using a smartphone app, providing both security and peace of mind. Through the use of IoT capabilities, this pet carrier provides a complete solution for pet transportation and travel with the integration of automated environmental control, increased security, and convenience to the users.

## Operating Instructions for the IoT Application Pet Carrier Box

This guide provides step-by-step instructions for using the IoT Application Pet Carrier Box effectively and safely. Follow these procedures to ensure optimal performance, pet comfort, and device longevity.

### 1. Device Setup

#### 1.1 Charging the Battery

- Ensure that the lithium-ion battery (12V 10A, 3.7V, 4 pcs) is charged for use.
- Plug in the charging adapter to the charging port of the carrier.
- The LED light will be red during charging and green when charged.
- Recommended charging time: 4-6 hours prior to first use.

#### 1.2 Powering on the Carrier

- Press the power button 3 times in a row until the indicator light illuminates.
- The system will initiate temperature sensors and the ventilation system automatically.

#### 1.3 Connecting with the Mobile App

- Download the IoT Pet Carrier App from Google Play Store or Apple App Store.
- Activate Wi-Fi on your smartphone and look for the device name in the application.
- Choose the carrier device, type in the default password, and connect.
- After being connected, live camera footage will be reflected on the app.

### 2. Putting Your Pet Inside

#### 2.1 Unlocking and Securing the Carrier

- Unlock the smart locking mechanism by pressing the unlock button on the control panel or mobile application.
- Carefully put your small to medium pet inside the carrier.

- Make sure the pet feels comfortable and has sufficient room (max size: 60cm x 50cm x 40cm).
- Close the carrier door securely, ensuring the automatic lock engages.

### 3. Operating the Smart Features

#### 3.1 Temperature and Ventilation Control

- The temperature sensor will continuously monitor the internal environment.
- If the temperature exceeds 35°C, the single cooling fan will automatically activate.
- You can also manually control the fan using the mobile app.

#### 3.2 Live Camera Monitoring

- Open the IoT Pet Carrier App and select the A9 mini night-vision camera.
- View the live video of your pet within the carrier.
- Enable the two-way audio option (if supported) to speak with your pet.

#### 3.3 Battery Monitoring

- The battery level will be indicated within the IoT Pet Carrier App.
- If the battery level goes below 10.5V, a low battery alert will be shown.
- Charge the carrier promptly to avoid system shutdown.

### 4. Maintenance and Storage

#### 4.1 Cleaning the Carrier

- Wipe the outside and inside using a damp cloth and gentle detergent.
- Discard the use of strong chemicals that may be harmful to the material or electronics.
- Pay attention to cleaning the air vents and the ventilation fan consistently to avoid the accumulation of dust.

#### 4.2 Storage of the Device

- Place in a cool, dry area away from the sun and water.
- Secure the battery at 50% or higher before storage.

### 5. Troubleshooting Guide

Issue	Possible Cause	Solution
Carrier does not power on	Low battery	Charge the battery for at least 30 minutes and try again.
Fan does not activate	Sensor malfunction	Restart the device and check temperature settings in the app.
Camera feed is not available	Poor connection	Ensure Wi-Fi/Bluetooth is enabled and reconnect the app.

Overheating inside the carrier	Inadequate airflow	Increase ventilation time via the app or move to a cooler location.
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## 6. Important Reminders

- Do not leave pets inside the carrier for extended periods without supervision.
- Always check battery levels before travel.
- Ensure the carrier is well-ventilated and properly closed.
- Do not expose the device to water, extreme heat, or impact damage.

## Safety Measures for Users and Pets

For the safe use of the IoT Application Pet Carrier Box, adhere to these measures to prevent any risks to pets and users.

### 1. Safety Measures for Pets

#### 1.1 Proper Placement of Pets

- Ensure the pet comfortably fits inside the carrier dimensions (60cm x 50cm x 40cm).
- Avoid forcing a pet into the carrier if it seems distressed or upset.
- Make sure the carrier is well secured prior to transportation to avoid unintentional escape.

#### 1.2 Temperature and Ventilation Safety

- Always verify through IoT app the pet within the carrier
- If the surrounding temperature is above 35°C, avoid extended usage of the carrier.
- Make sure the ventilation system is working properly prior to traveling.
- Never leave the carrier in sunlight or warm areas for long durations.

#### 1.3 Travel Safety

- Secure the carrier upright when it is being moved to avoid shifting or tipping.
- Keep pets out of the carrier and unattended for long periods of time.
- When using air or auto travel, ensure compliance with pet travel laws.
- Avoid stacking heavy things on the carrier since this might limit airflow.

#### 1.4 Emergency Handling

- In case the pet develops signs of heat stress or distress, take it out immediately and offer cool water and shade.
- Ensure that the battery is charged before use to prevent sudden loss of power.

### 2. Safety Precautions for Users

#### 2.1 Handling and Transport

- Always handle the pet carrier with the designated handle or grips for safe transport.
- Never lift the carrier with the pet when it weighs too much—call for help if necessary.
- Never try to adjust or take apart the electronic parts of the carrier.

#### 2.2 Electrical Safety

- Only use the suggested charger and power source to avoid electrical damage.
- Avoid exposing the carrier to water or moisture since it has electronic parts.

- Turn off the device at all times when cleaning or doing maintenance.
- Do not use the carrier if the battery is leaking or damaged.

### 2.3 Fire and Battery Safety

- Do not overcharge the battery; disconnect once charged.
- Keep the carrier away from open flames or high-temperature conditions.
- Keep the battery at room temperature and do not puncture or crush the power cells.
- In case of a burning odor or smoke, promptly turn off the power source and transfer the carrier to an open, safe location.

### 2.4 Maintenance and Inspection

- Inspect the carrier for damage prior to each use.
- Maintain cleanliness of the ventilation system and fan to keep it free from dust.
- Ensure that the locking device is functioning correctly before shipping.
- Replace defective sensors, battery packs, or fans as necessary to ensure performance.

## 3. Important Warnings

- ! Do NOT use the carrier if the IoT system, ventilation, or lock malfunctions.
- ! Do NOT leave pets inside the carrier in extreme heat or without monitoring.
- ! Do NOT use the device in wet or high-moisture environments.
- ! Do NOT allow children to operate the IoT functions without supervision.
- ! ALWAYS prioritize pet safety—check environmental conditions before travel.

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