

School of Computing and Engineering

BSc (Hons) Computer Science

Final Year Report

Pawfect Diet - Advancing Canine Nutrition with AI-Driven Personalised Solutions in a Mobile Application

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Abstract

The increasing integration of technology into everyday activities has highlighted a significant gap in effective canine nutrition management. Many dog owners still rely on non-veterinary sources for dietary guidance, as indicated by recent studies. Addressing this gap, the Pawfect Diet app was developed to leverage Artificial Intelligence (AI) to provide personalised, breed-specific dietary recommendations for dogs. The primary aim was to enhance the accuracy and personalisation of dietary advice, improving overall canine health and owner satisfaction.

The study hypothesised that AI technology could significantly improve the precision and customisation of dietary recommendations for dogs. To test this hypothesis, a mixed-methods approach was employed, including comprehensive surveys of dog owners and veterinarians to understand current dietary practices and identify potential improvements through AI integration. The app was developed using an iterative agile methodology, incorporating advanced AI technologies such as GPT-3.5 Turbo for generating daily dietary logs and TensorFlow for breed recognition.

Key features of the Pawfect Diet app include AI-generated daily logs, an interactive Vet Care chat, and robust calorie tracking, designed to offer accurate and tailored nutritional advice. Usability testing with 22 participants revealed high satisfaction rates with the app's personalised diet plans and calorie tracking capabilities, supporting the hypothesis that AI can effectively enhance dietary management for dogs. However, mixed trust levels in AI recommendations were noted, indicating the need for ongoing improvements in AI accuracy and reliability. Despite initial limitations, such as focusing primarily on Jack Russell Terrier and German Shepherd breeds and relying on manually imported food data, the Pawfect Diet app demonstrates significant potential in advancing AI-driven pet care.

In conclusion, the Pawfect Diet app represents a transformative advancement in AI-driven canine dietary management, offering scientifically grounded, personalised dietary recommendations that improve pet health outcomes and owner satisfaction. This project underscores the broader implications of AI in practical applications, demonstrating its potential to revolutionise pet care and fostering greater acceptance of AI-driven solutions among consumers and professionals. Future research should focus on refining AI models, expanding the breed database, and developing advanced user feedback mechanisms to further enhance the app's functionality and user experience.

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Finally, I would like to thank the _____, along with its dedicated staff and professors, who have guided and supported me from the very beginning of this academic journey.

Declaration

I, Nunzio Emanuele Sgroi, declare that the work presented in this dissertation titled "*Pawfect Diet: Advancing Canine Nutrition with AI-Driven Personalised Solutions*" is entirely my own, except where otherwise stated. This dissertation has been submitted in partial fulfilment of the requirements for the degree of Bachelor of Science in Computer Science at the _____.

I assert that:

- a) This dissertation is my own original work, completed under the guidance of my supervisor, _____.
- b) All sources of information and data have been properly cited and acknowledged.
- c) No part of this work has been submitted for any other degree or qualification at this or any other institution.

I am fully aware of the implications of plagiarism and confirm that this work is free from any form of plagiarism.

Signed,

Nunzio Emanuele Sgroi

Date: 16/05/2024

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List of Abbreviations

1. **AI** - Artificial Intelligence
2. **Vet** - Veterinary
3. **BSc** - Bachelor of Science
4. **Hons** – Honours
5. **UK** - United Kingdom
6. **FEDIAF** - Fédération Européenne de l'Industrie des Aliments pour Animaux Familiers
(European Pet Food Industry Federation)
7. **NRA** - Nutrient Profiling-Based Recommendation Algorithm
8. **AUC** - Area Under the Curve
9. **k-NN** - k-Nearest Neighbors
10. **SVD** - Singular Value Decomposition
11. **CNN** - Convolutional Neural Network
12. **NLP** - Natural Language Processing
13. **NLTK** - Natural Language Toolkit
14. **UI** - User Interface
15. **UX** – User Experience
16. **API** - Application Programming Interface
17. **ML** - Machine Learning
18. **JSON** - JavaScript Object Notation
19. **Expo** - Expo Development Framework
20. **iOS** - iPhone Operating System
21. **GPT** - Generative Pre-trained Transformer
22. **GitHub** - Platform for Version Control
23. **Expo CLI** - Expo Command Line Interface
24. **UI/UX** - User Interface/User Experience
25. **FR** - Functional Requirement
26. **NFR** - Non-Functional Requirement
27. **Pawfect Diet** - AI-driven application for canine dietary management
28. **ID** - Identifier
29. **IDE** - Integrated Development Environment
30. **VS Code** - Visual Studio Code
31. **CRUD** - Create, Read, Update, Delete
32. **CLI** - Command Line Interface
33. **AWS** - Amazon Web Services

Chapter 1

Introduction

1.1 Overview

The rapid advancements in Artificial Intelligence (AI) have significantly impacted various sectors, including healthcare, finance, and now pet care. However, a notable gap remains in effectively managing canine nutrition, a challenge faced by many pet owners. This dissertation introduces an AI-driven application, Pawfect Diet, designed to provide personalised dietary recommendations for dogs, addressing the complexities of ensuring proper canine nutrition, a need highlighted by studies such as Wainwright et al. (2022). These studies reveal that many dog owners rely heavily on non-veterinary sources for dietary guidance, underlining the need for reliable, science-backed information.

1.1.2 Motivation

The motivation for this project stems from a personal experience with adopting a puppy, which unveiled the widespread challenges and uncertainties pet owners face in managing their dogs' nutrition. Research indicates that a significant number of dog owners base their dietary decisions on past experiences rather than professional advice (J. Wainwright et al., 2022). This project aims to leverage AI technology to provide accessible and accurate nutritional guidance tailored to individual dogs, enhancing animal well-being and supporting pet owners with precise dietary recommendations.



Figure 1. 1 - My dog, Nami, ready to open her food delivery.

1.1.3 Problem Statement

Dog owners often struggle to provide balanced and appropriate diets for their pets, relying on generalised or outdated information. This issue is compounded by a lack of user-friendly tools offering personalised dietary advice. The gap between available technology and practical pet care solutions calls for a novel approach to canine nutrition management.

1.1.4 Background

Canine nutrition requires consideration of various factors such as breed, age, weight, and activity level. Traditional methods of managing dog diets often fall short in offering the tailored care individual dogs need. Recent studies emphasise the importance of personalised dietary plans to meet the specific nutritional requirements of different breeds and lifestyles (K. Kazimierska and W. Biel, 2020; A. Hoummady et al., 2022). Despite existing digital tools, most lack advanced AI capabilities to provide nuanced, personalised advice.

1.2 Introduction of Pawfect Diet

Pawfect Diet is an AI-driven mobile application designed to simplify canine dietary management with personalised, precise nutritional advice. It utilises advanced AI to deliver tailored recommendations and interactive features, enhancing dog care through comprehensive, user-friendly solutions. Key features include:

- **AI-Generated Daily Logs:** Creates daily diet plans based on each dog's profile and health goals, with options for user adjustments.

- Daily Log Feedback:** Provides AI-generated insights and suggestions for diet plan improvements.
- Breed Recognition:** Helps identify or confirm dog breeds to refine dietary recommendations.
- Interactive Vet Care Chat:** Offers virtual veterinary consultations, responding to user queries and enhancing engagement.
- Dynamic Profile Updates:** Detects and updates significant changes from user interactions.
- Comprehensive Calorie Tracking:** Monitors caloric intake to meet health and activity goals.
- Work Activity Tracking for Working Dogs:** Logs and manages dietary needs for work-related activities.
- User-Friendly Interface:** Ensures a seamless and engaging experience with an intuitive design and robust backend support.

Though AI technologies are integrated, Pawfect Diet remains in early development. The project is committed to continuous enhancement, focusing on user feedback and new technologies to evolve into an essential tool for comprehensive canine dietary management.

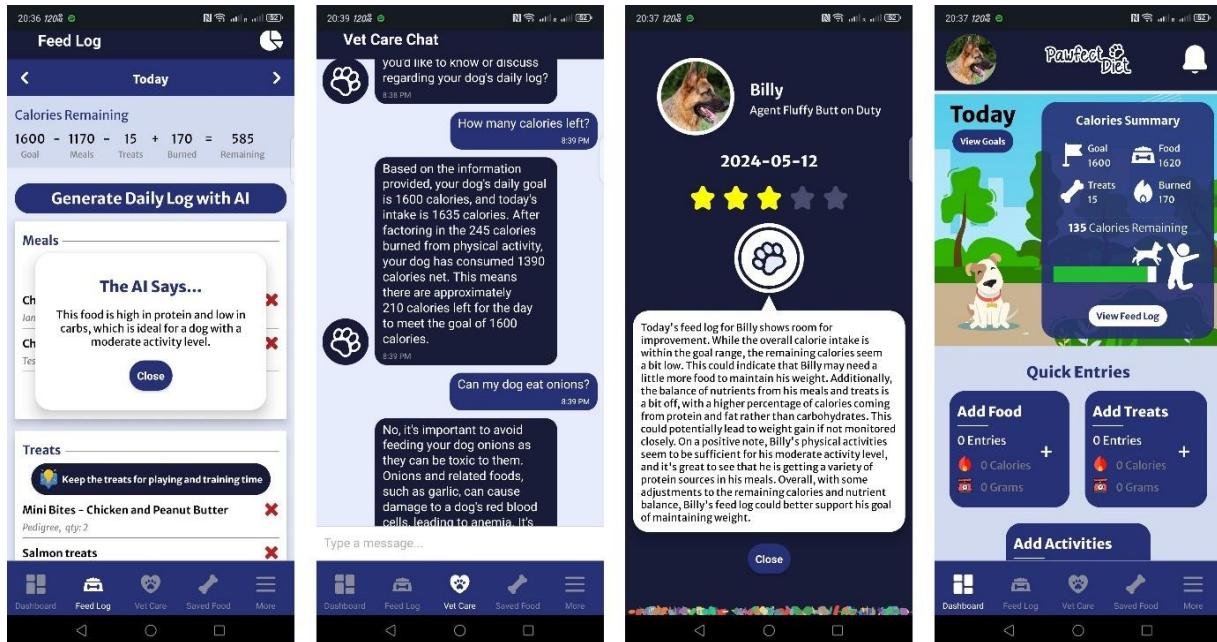


Figure 1.2 - Preview of Pawfect Diet

1.3 Project Scope

1.3.1 Aims

To develop a user-centric AI-driven mobile application for canine diet and nutritional management that offers personalised dietary plans, tracks calorie intake, and provides nutritional advice specifically tailored to individual dog breeds and their unique activity level, with an emphasis on enhancing user engagement and satisfaction through a user-friendly interface.

1.3.2 Objectives

- Conduct Comprehensive Literature Review:** Examine current canine nutritional science, AI applications in pet care, and the market landscape of existing diet management solutions to inform the app's development.

- **Understand Dog Owners' Needs and Expectations:** Use surveys to identify current pain points, needs, and preferences, ensuring the app's features are aligned with real-world requirements.
- **Incorporate Veterinary Expertise:** Gather recommendations on breed-specific dietary needs and professional insights from veterinarians to integrate into the app's development.
- **Design a Human-Centred, User-Friendly Application:** Develop an intuitive interface with features for profile management, dietary tracking, and AI-driven advice, ensuring the app is engaging, easy to use, and meets user needs effectively.
- **Integrate AI Technologies:** Implement robust AI functionalities to provide precise, personalised dietary recommendations, tailored to individual dog breeds and their unique nutritional requirements.

1.3.3 Research Questions

1. How effective are AI-generated dietary recommendations in providing accurate, breed-specific nutrition plans for dogs?
2. What are the main challenges and solutions in integrating AI with user input for precise canine diet tracking?
3. How do pet owners perceive the trustworthiness of AI in managing their dogs' diets, and what features ensure the reliability of its recommendations?
4. What design principles and user interface features are critical for creating an intuitive and engaging AI-driven dog diet app?

1.4 Significance of the Study

The study significantly advances pet care and AI by introducing an innovative approach to canine nutrition through AI-driven, customised dietary recommendations, setting a new standard in pet care technology. It enhances AI's role in daily life, promoting broader acceptance and trust, and emphasises user-centric design, simplifying complex nutritional management to boost user engagement. Additionally, it provides a foundation for future AI-driven pet care research and bridges critical gaps in current canine dietary practices by integrating insights from veterinarians and dog owners, ensuring scientific grounding and practical relevance.

1.5 Dissertation Outline

The chapters of this dissertation are structured as follows:

Chapter 2 - Literature Review: Reviews existing research on canine nutrition, AI in pet care, and current diet management solutions, identifying gaps and opportunities for Pawfect Diet.

Chapter 3 - Methodology: Details the research design, including surveys of dog owners and veterinarians, data collection, and analysis, as well as the iterative agile approach for app development.

Chapter 4 - Results and Findings: Analyses survey data from dog owners and veterinarians, highlighting current practices, challenges, and the benefits of AI integration for the app's development.

Chapter 5 - Design: Explores the app's design strategies, covering functional and non-functional requirements, user interaction, usability goals, and prototyping.

Chapter 6 - Implementation and Testing: Discusses the technical development of the app, AI integration, system architecture, and the results of unit and usability testing.

Chapter 7 - Discussion and Conclusion: Evaluates the study's findings, app performance against research objectives, and discusses implications, limitations, and future research directions.

Chapter 2

Literature Review

2.1 Chapter Overview

This literature review critically examines the multidimensional aspects of canine nutrition, focusing on the necessity and feasibility of employing Artificial Intelligence to deliver personalised diet plans for dogs. It aims to explore various significant studies to determine the prevalent issues faced by dog owners in managing canine nutrition, assess the contributions of veterinary science, and understand the capabilities and applications of AI in this context. Additionally, this section reviews existing solutions to identify gaps in current technologies and applications, which this project seeks to address. By incorporating case studies and systematic evaluations of existing digital aids, this review establishes a solid foundation for the development of an AI-driven application that provides tailored dietary recommendations, thus enhancing the overall health and well-being of dogs.

2.2 Understanding Canine Nutritional Needs and Owner Pitfalls

The project was inspired by personal motivation, yet it's crucial to determine its broader relevance. FEDIAF EuropeanPetFood reports a significant expansion in Europe's pet population, with 90 million households (46%) owning pets, including an estimated 90 million dogs (FEDIAF EuropeanPetFood, 2022). This includes an estimated 90 million dogs across the continent. Similarly, Statista notes that 31% of UK households owned at least one dog in 2023, maintaining a stable trend from 2010 to 2020 (Statista, 2024). Despite observable trends of sustained dog ownership, there are studies that suggest even higher figures. For instance, research by A. Carvelli and colleagues (2020) highlighted that in Italy, at least one out of ten dog owners had not registered their pet. These indicators suggest that a significant portion of the population is engaged in managing canine nutrition, highlighting the relevance and urgency of addressing this aspect of pet care effectively.

In a significant study conducted by J. Wainwright, K.M. Millar, and G.A. White (2022), the researchers explored the perceptions of dog owners regarding canine nutrition and wellbeing, particularly how these views are influenced by the dogs' weight status. Utilising structured interviews with 147 dog owners in the East Midlands, UK, the study revealed that a majority of the owners relied on "past experience" to decide their dogs' diets, with only 9% consulting veterinarians for dietary decisions. This disconnect is further illustrated in the finding that only 22% of owners with overweight dogs accurately assessed their pets' weight when compared to non-sequential body condition score images, versus 89% accuracy among owners of dogs at ideal weight. The study underscores a general awareness among owners about the link between diet and canine wellbeing, yet points to significant gaps in accurately understanding and prioritising the factors that contribute to health, such as weight management. The authors suggest that veterinarians should integrate discussions of nutrition and weight into routine consultations and consider using visual aids to help owners gain a more realistic view of their pets' weight status, which could improve outcomes in canine health management.

S. Hoummady et al. (2022) examined canine nutrition based on owner dietary choices in France, comparing conventional (dry/wet food) and non-conventional (raw food) diets. The study found significant lifestyle and trust differences in veterinary advice between these groups. Notably, 38% of respondents fed their dogs exclusively non-conventional diets, relying on non-veterinary sources, while 47% of conventional diet feeders followed packaging guidelines. Owners of non-conventional diet dogs also engaged more in activities like frequent, leash-free walks. These insights are vital for veterinarians, highlighting the need for tailored communication and education. Integrating these findings into Pawfect Diet could improve dietary recommendations based on owner preferences.

When tailoring canine nutrition, it's essential to consider factors like breed, weight, age, lifestyle, gender, and reproductive status. Dr. A. Gautam et al. (2018) emphasise that these factors, including pregnancy, lactation, and neutering, significantly impact a dog's nutritional needs. Pregnant or lactating females need more nutrients for fetal development and milk production, while neutered dogs may require dietary adjustments due to metabolic changes. Addressing these variables can optimise health outcomes, enhancing gastrointestinal health, biochemical parameters, and immune functions.

K. Kazimierska and W. Biel (2020), along with Zoran (2021), highlight the distinct nutritional needs of working versus non-working breeds. These studies stress the importance of tailoring nutrition based on the type of work, weight, age, and lifestyle. For example, a Jack Russell Terrier in a jumping competition needs more calories and higher protein intake compared to one in dog therapy, reflecting the differing nutritional demands of their activities.

Morelli et al. (2020) studied dog owners' attitudes towards commercially available treats, revealing that 83% of surveyed owners ($n = 1833$) regularly use treats as rewards or during training and sports activities. Common choices include biscuits and dental care sticks, with owners typically giving one to five pieces daily. While many prioritise nutritional information, a significant number also consider factors like flavour, brand, or shape. Additionally, 75% ($n = 1369$) follow feeding instructions provided by treat producers. This variability highlights the need for veterinarians to understand these attitudes to better educate owners on managing treats in their dogs' diets.

In conclusion, these studies offer crucial insights into the complexities of canine nutrition, emphasising the need for tailored dietary recommendations. From understanding owner attitudes towards treats to delineating the nutritional requirements of working dogs, these findings underscore the importance of personalised approaches. Moving forward, integrating these research findings into the development of an AI-driven nutritional guidance application is essential to meet the diverse needs of both dogs and their owners, ultimately improving canine health outcomes.

2.3 The Role of AI

Artificial Intelligence is transforming numerous industries, including pet care and nutrition. This section explores AI's role in enhancing companion animal health and well-being. It also analyses studies that, while not directly related to this project, offer insights that inform the development of AI-driven features in Pawfect Diet and improve our approach to canine nutrition management.

The research conducted by H. Song and Y. Kim (2021) presents a valuable contribution to the development of our AI-driven application. Addressing the growing need for tailored food recommendations for dogs based on their health conditions, their study introduces a novel approach called the Nutrient Profiling-Based Recommendation Algorithm (NRA). This algorithm utilises a combination of user experiences and expert knowledge to identify the necessary nutrients for dogs and recommend the most suitable dog food options accordingly. Notably, their NRA outperforms alternative models, demonstrating a 20% improvement in AUC over k-NN and a 9.7% improvement over the SVD model. Furthermore, the NRA is designed as an evolving system that continuously improves its recommendations through user feedback. By integrating insights from this research, our AI-driven application stands to enhance its accuracy and effectiveness in providing personalised dietary recommendations for dogs.

The work by Parminder S. Basran and R. Appleby (2022) delves into the expanding role of AI within veterinary medicine. While their study does not specifically address AI applications in canine

nutrition, it offers valuable insights into AI's utilisation across pet care domains. By examining AI fundamentals such as machine learning and image analysis, Basran and Appleby demonstrate AI's versatility in tasks ranging from disease detection to precision medicine. Despite the focus on broader veterinary applications, their research underscores the potential for AI to revolutionise various aspects of pet health management. Integrating their findings into our discussion enriches our understanding of AI's multifaceted contributions to veterinary practice, including its potential implications for advancing canine nutrition management strategies.

Understanding dog breeds is crucial for effective canine nutrition management. E. Madhan and colleagues (2022) explored image processing techniques for classifying dog breeds using machine learning and deep learning. They developed a CNN model deployed on Google App Engine, utilising a dataset of 10,222 images, achieving 81% accuracy in breed prediction. The model identifies features like paw, nose, and ears, with a training accuracy of 90% and validation accuracy of 81%. This research is valuable for enhancing breed recognition features in the app, particularly for dog owners uncertain of their dog's breed.

The potential of AI extends far beyond canine nutrition. M. Côté and B. Lamarche's (2021) research on human dietary analysis provides a foundation for applying similar AI methodologies to canine diets. Techniques such as predictive modelling and dietary assessment, explored in their study, are highly applicable to refining AI tools for analysing canine dietary patterns. Insights from human nutrition research enhance our understanding of AI's capabilities and pave the way for innovative approaches in canine nutrition studies.

As anticipated earlier, Pawfect Diet includes an integrated AI-driven chat feature designed to enhance the speed and technical performance of the app. This feature aims to provide users with quick access to information and tailored advice, leveraging AI capabilities similar to those found in ChatGPT. Research by M. Garcia (2023) supports the use of such AI tools, demonstrating that they can significantly improve users' nutritional knowledge and provide Personalised dietary guidance, although they are not yet advanced enough to replace professional advice.

Further emphasising the potential of this feature, a survey conducted by P. Sahu and A. Kumari (2023) found that nearly all participants used AI chats to accelerate their learning process, treating these tools as a quicker alternative to traditional search methods. Additionally, statistics indicate widespread adoption of AI-driven chats, with more than 1 billion people having used a chatbot at least once (Cherniak, 2024), and specific apps like ChatGPT and Gemini mobile application accumulating over 4 million downloads between May 2023 and February 2024 (Statista, 2024).

These insights suggest that incorporating an AI-driven chat into Pawfect Diet could provide significant benefits by mimicking veterinary advice and offering Personalised recommendations. It is crucial, however, to clearly communicate the limitations of this AI feature to users and ensure it complements but does not replace professional veterinary advice. This balanced approach can help users gain a better understanding of their dogs' dietary needs while acknowledging the technology's current limitations.

2.4 Analysis of Existing Solutions

To gauge the current landscape of digital tools for canine nutrition management, a review of seven existing apps was undertaken (table 2.1). This analysis aimed to identify whether these apps utilise AI, their feature sets, and how they are received by users.

Surprisingly, none of the reviewed apps use AI; they mainly provide information and reminders, like medication schedules. Notably, only "Capy Diet," "PAWSM," and "Nutripet Dog" offer calorie tracking, a key feature of this project. All apps require manual data entry, such as inputting a dog's actual and desired weight and daily calories, highlighting the lack of automation in diet management. The popularity of these apps is limited, with "Dog Log" being the most downloaded at 50,000 times, and "Capy Diet," closely aligning with our project's goals, has just 180 downloads. This suggests a significant market opportunity for a more advanced tool that uses AI to provide Personalised dietary management.

App Name	AI Usage	Calorie Tracking	Breed Recognition	Chatbot	Downloads	Ratings	Note
Can Dog Eat It (Matthew Wilson)	X	X	X	X	12,000	3.1/5 (48 ratings)	Provides basic information on safe and unsafe foods for dogs.
PAWSM (PAWSM)	X	✓	X	X	1,300	1.8/5 (7 rating)	Syncs with a Bluetooth-enabled bowl to weigh food. Requires manual entry of daily caloric intake for calorie tracking
Dog Log (Lynn Marks)	X	X	X	X	50,000	4.5/5 (951 ratings)	Functions as an activity tracker and reminder.
Clio: Dog Cat Pet Tracker (The Lazy Hippo Dev.)	X	X	X	X	21,000	4.0/5 (350 ratings)	Functions as an activity tracker and reminder.
Nutripet Dog (Ambiotec Balance)	X	✓	X	X	10,000	2.0 (24 ratings)	Available only in Spanish. Enables manual entry of dog's nutritional needs and calorie tracking.
Capy Diet (Starry Web)	X	✓	X	X	180	No Ratings	Allows manual entry of dog's needs and daily nutrition; supports calorie tracking based on user input.

Table 2. 1 - Analysis of Pet Nutrition Management Applications Available on Various App Stores

2.5 Research Gaps and Future Implications

A review of existing literature on canine nutrition and AI integration highlights key areas needing further research, suggesting directions for future investigations:

- AI in Canine Nutrition:** There's a significant gap in AI's targeted application for enhancing dietary recommendations and nutritional management for dogs.
- Nutritional Communication:** Effective communication of canine nutritional status, particularly weight management, is lacking. This project proposes AI solutions to provide dietary recommendations and educate owners via a chat system.
- Breed-Specific Management:** There is a lack of AI-driven systems catering to breed-specific nutritional needs. This initiative aims to create an AI app that personalises nutrition plans based on breed, age, and activity levels.

Addressing these gaps will enhance AI's role in canine nutrition and may lead to broader innovations in veterinary medicine and pet care technology, improving Personalised care across various aspects of veterinary practice.

2.6 Summary

This literature review has synthesised key aspects of canine nutrition, owner behaviours, and the potential of Artificial Intelligence in enhancing dietary management for dogs. It underscores significant research gaps, particularly in the tailored application of AI in canine nutrition, which this project aims to address. By leveraging AI to provide Personalised dietary recommendations, this initiative not only seeks to improve canine health but also sets the stage for broader innovations in veterinary medicine. The anticipated outcomes of this research could significantly advance pet care practices, offering a model for integrating AI into various aspects of veterinary care.

Chapter 3

Methodology

3.1 Chapter Overview

This chapter delineates the methodologies employed throughout the project, emphasising the processes of data collection and analysis. It details the sequential phases of the research methodology, each critical to the project's success. The chapter is structured to discuss core activities integral to the development of Pawfect Diet, including requirement gathering, system design, construction, and testing. Each stage is explored in depth to provide a clear understanding of how these foundational elements collectively contribute to the robust development and evaluation of the application, ensuring it meets both the specified requirements and anticipated research outcomes.

3.2 Research Design

This section describes the mixed-methods research methodology used to assess the development and effectiveness of an AI-driven canine nutrition app. Structured surveys targeting dog owners and veterinarians were employed to collect both qualitative and quantitative data. This dual approach provides comprehensive insights from app end-users and professionals with technical expertise in canine dietary needs (R. Streefkerk, 2019). The methodology aims to integrate diverse perspectives on canine dietary habits, concerns of owners and veterinarians, and the potential enhancements via AI, ensuring a thorough analysis to inform robust app development.

3.2.1 Data Collection

3.2.1.1 Survey for Dog Owners

The survey targeted dog owners to understand their current practices, challenges, and needs concerning managing their dogs' diets. It included both closed-ended and open-ended questions, allowing respondents to provide detailed feedback on their experiences and expectations. Questions ranged from demographic information about the dog (such as breed and age) to more subjective measures of their satisfaction with current dietary management solutions and openness to using an AI-driven app.

3.2.1.2 Survey for Veterinarians

A separate survey was conducted with veterinarians to harness their expert opinions on canine nutrition and the potential role of AI-driven tools in diet management. This survey focused on their professional assessments of common nutritional mistakes made by dog owners, the importance of breed-specific diets, and their perspectives on the reliability and utility of AI in their practice.

3.2.2 Data Analysis

Quantitative survey data were analysed using statistical tools, employing descriptive statistics to summarise and inferential statistics to generalise about dog owners and veterinarians (R. Streefkerk, 2019). Qualitative data from open-ended responses were analysed through thematic analysis using Python and the NLTK library, which helped organise data into themes by identifying and coding patterns. This involved tokenising text, removing stop words, and applying natural language processing techniques to extract significant themes (B. Steven et al., 2009). This analysis provided in-depth insights into concerns and misconceptions about AI in canine nutrition, enriching the study with nuanced perspectives from users and professionals (R. Streefkerk, 2019).

3.3 Software Development Methodology

This section outlines the Agile development methodology employed to create the AI-driven canine nutrition app. This iterative approach was integral in ensuring the app not only met technical expectations but was also user-centred, addressing real-world usability and functionality.

3.3.1 Iterative Development Approach

The development process utilised iterative cycles, each focusing on specific app segments. Each cycle involved planning, execution, and review phases, enabling rapid adjustments based on user feedback to enhance functionality and user-friendliness (C. Fagarasan et al., 2021).

- Design and Feedback Loop:** Initial design elements were developed and presented to participants for feedback, leading to design revisions or progression based on feedback.
- Development and Testing:** Front-end and back-end functionalities were developed in parts, tested by participants, and refined based on their feedback.
- Feedback Integration:** Iterative cycles ensured continuous alignment with user expectations and practical functionality, validating assumptions and enhancing the app.

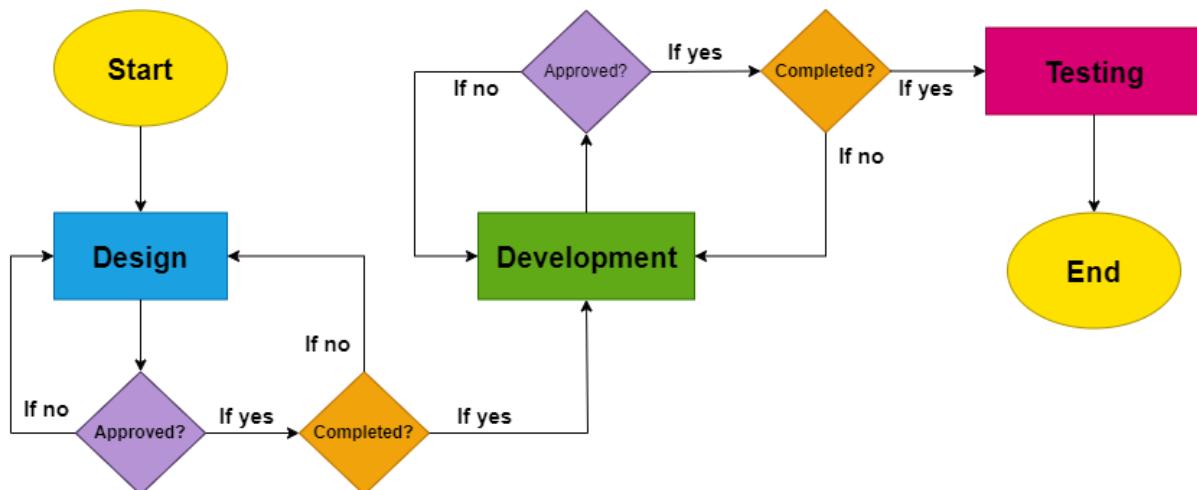


Figure 3. 1 - Iterative Agile Approach Flow Chart

3.3.1.1 Development Tools and Technologies

In developing Pawfect Diet, a variety of advanced tools and technologies were employed across different stages of the project to ensure functionality, design integrity, and effective project management. The table below summarises these tools and their specific roles within the project.

Tool/Technology	Purpose	Usage in Project
Figma	UI/UX Design	Used for designing the app interface and user experience (Figma).
React Native Expo	App Development Framework	Enabled development of iOS and Android versions with a single codebase (Expo).
Firebase	Database Management	Provided backend services and database solutions (Google).
GPT-3.5 Turbo API	AI Conversational Capabilities	Utilised to power the chatbot feature that simulates veterinary advice and to generate Personalised diet plans, leveraging its advanced natural language processing capabilities (OpenAI).

Teachable Machine	ML Model Creation	Used to develop breed recognition models (Google).
TensorFlow	ML Model Integration	Integrated breed recognition model into the app (TensorFlow).
GitHub	Version Control	Managed changes and versions of the project (GitHub).
Expo App	App Testing and Deployment	Used for deployment, real-time testing and feedback collection from participants (Expo).
Android Studio Emulator	App Simulation and Testing	Tested app functionalities on simulated Android devices (Google).

Table 3. 1 - List of Tools and Technologies Used During Design and Development of Pawfect Diet

3.3.1.2 App Limitations

Upon completion, the Pawfect Diet app will have the following limitations:

- Breed-Specific Focus:** The Pawfect Diet app is initially designed specifically for Jack Russell Terrier and German Shepherd breeds. This design choice aims to demonstrate the effective integration of AI with a rule-based system for developing customised health goals.
- Hybrid Approach for Health Goals and Caloric Calculations:** Due to calculation limitations of the chosen AI model, the app employs a hybrid method, where health goals and caloric needs are manually calculated and integrated with AI functionalities. This approach includes:
 - User-Created Profiles:** Detailed profiles are created by the users, capturing essential information about their dogs.
 - System-Calculated Health Goals:** Health objectives are derived based on user-provided profiles.
 - AI-Generated Diet Plans:** The AI generates tailored diet plans aligned with the system-calculated health goals.
 - System-Calculated Caloric Requirements:** The AI suggests food quantities to meet the caloric needs and then calories are manually calculated.
- Limited Dog Food Database:** The application does not integrate a public database for dog food items. Instead, food data is manually sourced from reputable online resources. This results in an initially limited selection of available dog food options within the app. The imported food details are formatted in JSON and incorporated into the database (figure 3.2).

3.3.1.3 App Structure

The Pawfect Diet app features 10 main screens (table 3.2), each equipped with essential components vital for this research. Non-essential elements are excluded in this development phase. The app's frontend includes both operational features and placeholders for future functionalities, providing a realistic demonstration of the intended full experience. This approach ensures clarity on the app's final functionality.

```
{
  brand: "Orlando",
  name: "Salmon & Chicken Recipe Pate",
  type: "commercial",
  foodType: "wet",
  servingSize: {
    puppy: 45,
    small: 75, // grams
    medium: 150,
    large: 300,
  },
  nutritionalInfo: {
    protein: 11,
    carb: 5,
    fat: 4,
    caloriesPerGram: 1.5,
  },
  ingredients: [
    {
      IngredientType: "salmon",
      amount: 70, // percentage
    },
    {
      IngredientType: "chicken",
      amount: 20, // percentage
    },
    {
      IngredientType: "sweet potato",
      amount: 10, // percentage
    },
  ],
}
```

Figure 3. 2 - Example of Dog Food Data Formatted in JSON

Screen	Description	Priority
Login	The entry point where users authenticate.	Low
Sign Up	Designed for new users to create an account.	Low
Dog Profile Creation	Allows users to input comprehensive details about their dog. Options adjust based on the dog's gender and whether it is a working dog. Users can also specify their dog's favourite foods and further personalise the profile to enhance the tailored experience.	High
Breed Recognition	An ML-driven feature that suggests the dog's breed based on uploaded images.	Medium
Dashboard	The central hub that provides a quick overview of all key features and offers calorie tracking.	Medium
Feed Log	This screen enables users to create and adjust daily diets and activities for their dogs, using AI or opting for manual entries. The AI analyses each log upon closure, providing tailored suggestions based on the dog's dietary and activity requirements. Users can access past and future logs, track calories and see real-time updates on calorie consumption as new data is entered.	High
Vet Care	This screen features an AI-driven chatbot that simulates a veterinary consultation, enhancing user interaction with intelligent capabilities. The chatbot includes a detection system that identifies significant changes or updates mentioned during the conversation. When key details about the dog's profile are discussed, the system prompts the user to confirm if they wish to update the dog's profile accordingly.	High
Health Goals	This screen provides users with an overview of the health goals calculated for their dog, including target weight and daily calorie intake.	High
Switch Dog Profile	Enables users to manage multiple dog profiles easily	Low
Menu	Provides access to all screens and allow users to log out.	Low

Table 3. 2 - Overview of the Developed Screen of the Current State of Pawfect Diets

3.4 Participant Involvement

This project engaged external participants in three phases: pre-development surveys, development phase, and post-development usability testing.

1. **Surveys Pre-Development:** Participants provided essential data on canine diet management practices and challenges, shaping the app's initial design and features (section 3.2).
2. **Development Phase:** A subset participated in the Agile iterative process, offering continuous feedback.
3. **Usability Testing Post-Development:** Participants tested the final app version, focusing on user experience and suggesting final refinements.

3.5 Ethical Considerations

In developing the AI-driven canine nutrition app, Pawfect Diet, ethical integrity was paramount. Participant privacy was protected through anonymisation and secure data storage, and informed consent was obtained from all participants, ensuring transparency about the research's purpose and their rights. Ethical AI use was prioritised to avoid biases, with mechanisms to ensure accuracy and fairness in dietary recommendations. It was also emphasised that the app is a supplementary tool and not a substitute for professional veterinary advice, maintaining ethical standards and promoting responsible usage.

3.6 Summary

This chapter detailed the methodologies employed in developing the AI-driven Pawfect Diet app, utilising both qualitative and quantitative research to incorporate insights from dog owners and veterinary professionals into its design. Advanced tools and an Agile development approach were employed to ensure the app's precision, adaptability, and user-centric functionality. Ethical considerations were strictly followed, safeguarding participant data and ensuring the responsible use of AI. This comprehensive methodological approach facilitated the creation of a robust, user-friendly, and ethically sound app. The iterative feedback and testing cycles were pivotal in refining the app, establishing it as a dependable tool for canine dietary management.

Chapter 4

Analysis and Findings

4.1 Chapter Overview

This chapter presents a comprehensive analysis of survey data collected from dog owners and veterinarians, focusing on current practices, challenges, and the potential for integrating AI in canine dietary management. The findings provide essential insights into the development of the AI-driven app, Pawfect Diet, aimed at enhancing canine health and nutrition through modern technology. Initially, the chapter examines the dog owners' survey results, highlighting their dietary practices, challenges in nutritional management, and openness to AI technology. It then explores veterinarians' perspectives on canine nutrition and the integration of AI in their professional practice.

4.2 Analysis of the Dog Owners' Survey

The survey captured responses from a diverse group of 83 dog owners, encompassing a wide range of breeds and ages, including 10 working dogs. A significant proportion of the dogs, notably 20 out of 83, were mixed breeds, emphasising the app's need to accommodate varied dietary requirements. The survey's broad representation of breeds, from active working dogs to those with more sedentary lifestyles, and the age distribution from puppies to senior dogs, underlines the importance of an AI application that can adapt dietary advice to suit different life stages, activity levels, and individual breed characteristics.

Category	Description	Count
Mixed-Breed	Number of mixed-breed dogs included in the survey	20
Popular Breeds	Breeds represented by four or more participants	Jack Russell Terrier: 5 Labrador retriever: 5 German Shepherd: 4 Chihuahua: 4
Other Breeds	Small representation breeds	45
Age Distribution	Dog's age breakdown	Less than 1 year: 18 1 – 3 years: 22 4 – 7 years: 25 8 years and above: 18
Working Dogs	Dogs involved in high-intensity activities such as competitions, service work, running, etc.	10
Total Surveyed	-	83

Table 4. 1 - Summary of Surveyed Dog Demographics and Characteristics

The survey revealed diverse dietary management methods among dog owners. Out of 83 respondents, 34.9% (29) predominantly follow their veterinarians' advice, showing a strong reliance on expert guidance. Around 26.5% (22) of dog owners turn to online resources to create diet plans, highlighting the significant role of digital information in decision-making. Mobile app utilisation for diet tracking is still emerging, with approximately 12% (10) of participants using these tools, suggesting room for growth in digital diet management adoption.

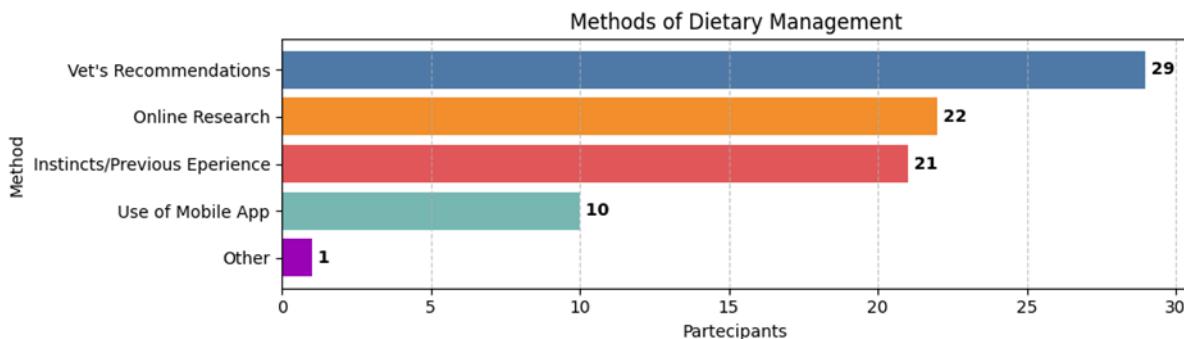


Figure 4. 1 - Distribution of Methods Used by Dog Owners for Dietary Management

Regarding confidence in nutritional understanding, the survey participants exhibited a moderate average confidence level, with a mean score of 3.58. However, new dog owners reported particular challenges in diet management, as indicated by a mean difficulty level of 3.60 for managing their dog's diet upon adoption. These insights point to a need for more accessible and reliable dietary guidance, particularly for those less experienced in canine care.

The engagement of dog owners with AI and digital tools in managing their dogs' diets presents a varied picture. Out of 83 participants, 23% have already used AI services for dietary advice, while a prominent 59% have not used any app or AI service for this purpose, indicating a substantial untapped market. The level of trust in AI-driven applications is generally optimistic, with 55% of respondents expressing trust. However, there are prevalent concerns, particularly regarding the accuracy (34%), breed-specific customisation (8%), and sensitivity to health issues (5%), suggesting areas where AI applications need to enhance their capabilities to gain broader acceptance.

In terms of app feature preferences, personalised diet plans and calorie tracking emerged as highly desired, with each feature chosen by 59 respondents. This preference underscores a need for apps that offer a blend of tailored advice and practical functionality. Moreover, the willingness of a majority of dog owners to manually input meal data, with 66 out of 83 showing readiness for active involvement, highlights a preference for apps that balance AI-driven insights with user control.

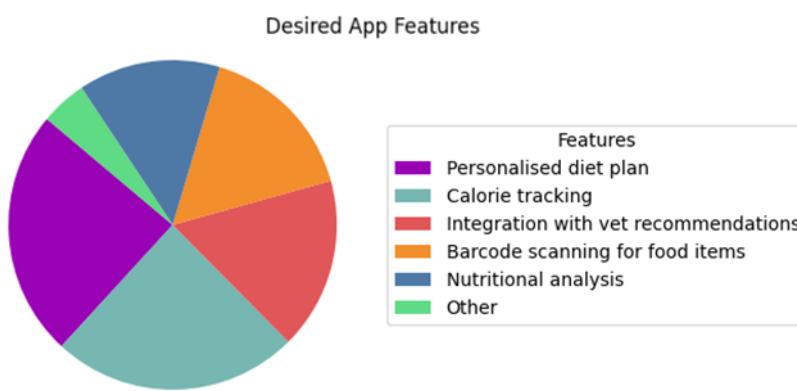


Figure 4. 2 - Preferred Features for Canine Diet Management App According to Surveyed Dog Owners

The survey also identified common dietary challenges faced by dog owners. Managing calorie intake was a primary concern for 41% of respondents, while ensuring a balanced diet was a challenge for 35%. These insights stress the need for features in the app that specifically address these common issues. Moreover, the majority of users prefer simple and straightforward app functionalities, indicating that ease of use and user-friendliness are critical considerations in the app's design.

4.2.1 Interpretation

The survey results underscore a strong potential for an AI-powered dietary management app like Pawfect Diet. Key implications include:

1. **Personalised Diet Plans:** The high interest in personalised diet plans and calorie tracking underscores the need for features that offer tailored dietary advice. Pawfect Diet should focus on providing customised meal plans based on the dog's breed, age, and activity level.
2. **User-Friendly Interface:** The willingness of a majority of dog owners to manually input meal data suggests that the app should balance AI-driven insights with user control. Ensuring an intuitive interface that simplifies data entry and provides clear feedback is crucial.
3. **AI and Digital Tool Adoption:** With 23% of participants having used AI services for dietary advice, there is a significant opportunity to expand AI integration. However, concerns about accuracy, breed-specific customisation, and sensitivity to health issues must be addressed to enhance trust and adoption.
4. **Educational Components:** The moderate confidence in nutritional knowledge indicates a need for educational features within the app. This could include tips on balanced diets, calorie management, and the benefits of specific nutrients, enhancing user engagement and satisfaction.

4.3 Analysis of the Veterinarians' Survey

The veterinarian survey, though smaller with 13 participants, provides critical insights into canine dietary management from a professional perspective. Notably, 61% of these veterinarians have less than five years of practice, representing a younger demographic likely more open to new, tech-driven approaches. Their insights are crucial in understanding the potential and readiness for AI adoption in canine dietary management.

Years of Practice	Number of Veterinarians
Less than 5 years	8
5 - 10 years	2
10 - 15 years	1
More than 15 years	2
Total Surveyed	13

Table 4. 2 - Summary of Surveyed Veterinarians Demographics

A notable 92% of veterinarians frequently encounter diet-related health issues in dogs, underscoring the need for improved dietary management tools. Common errors like overfeeding and unbalanced diets suggest a broad lack of owner knowledge. Veterinarians' focus on breed-specific diets indicates a trend towards personalised pet care, highlighting the potential for AI-driven tools to provide tailored advice for various breeds.

The survey shows veterinarians have a cautiously optimistic view of AI in canine nutrition, recognising its potential for personalised diet plans but expressing concerns about accuracy and reliability. This highlights the need for innovative, scientifically validated AI solutions that align with veterinary standards. Veterinarians' willingness to recommend AI-driven apps suggests a demand for features meeting both professional and owner needs.

Preferences among veterinarians strongly favour features such as calorie tracking, which was unanimously supported, indicating its essential role in effective dietary management. Additionally,

the demand for nutritional analysis and integration with veterinary recommendations reflects a desire for comprehensive tools that combine AI capabilities with professional expertise. Over half of the respondents also valued Personalised diet plans, emphasising the need for AI tools that can offer customised dietary advice based on each dog's specific needs. These collective preferences underscore the importance of developing an AI application that seamlessly integrates detailed nutritional tracking with Personalised recommendations to support overall canine health.

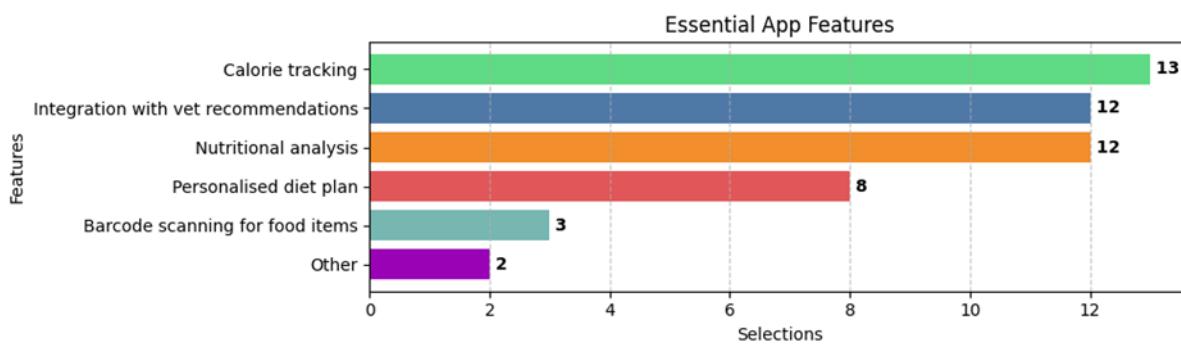


Figure 4. 3 - Recommended Features for Canine Diet Management App According to Surveyed Veterinarians

4.3.1 Interpretation

The survey results from veterinarians reinforce the potential of AI-driven solutions like Pawfect Diet. Key implications include:

- Breed-Specific Customisation:** Veterinarians' strong support for breed-specific diets aligns with the need to integrate detailed breed information into the app's AI algorithms. This ensures that dietary recommendations are accurately tailored to each dog's unique requirements.
- Calorie Tracking and Nutritional Analysis:** The unanimous preference for calorie tracking among veterinarians underscores its critical role in effective dietary management. Pawfect Diet should prioritise developing robust calorie tracking features, ensuring they align with veterinary standards for accuracy and reliability.
- Trust and Reliability of AI:** The cautiously optimistic view of AI's potential, tempered by concerns about accuracy and reliability, highlights the importance of developing scientifically validated AI solutions. Ensuring that AI-generated recommendations are consistent with veterinary best practices is essential for gaining professional endorsement.
- Integration with Veterinary Recommendations:** The demand for tools that integrate nutritional analysis with veterinary advice suggests a need for features that allow seamless collaboration between pet owners and veterinarians. This could include options for veterinarians to review and adjust dietary plans, enhancing the app's credibility and utility.

4.4 Cross-Analysis and Interpretation

The comparative analysis of surveys from dog owners and veterinarians offers a detailed view of canine dietary management, informing the development of Pawfect Diet. This section highlights key overlaps and differences, guiding app feature enhancements and user engagement strategies.

1. Personalised Dietary Plans:

- Findings:** Both groups value breed-specific, personalised dietary plans, with veterinarians advocating a holistic approach that includes age, weight, and activity level.

- **Interpretation:** This alignment underscores the need for educating owners on comprehensive dietary factors beyond breed. The app should include features that educate users on a broad dietary approach, improving decision-making for their pets' nutrition.

2. Adoption and Usage Gaps:

- **Findings:** Dog owners are more inclined towards digital tools and AI for dietary management than veterinarians, who may be less comfortable with technology.
- **Interpretation:** To bridge this gap, the app should enhance user-friendliness and clearly demonstrate AI's benefits, encouraging greater acceptance among veterinarians and higher usage among dog owners.

3. Building Trust in AI:

- **Findings:** Dog owners are generally positive about AI-driven recommendations, while veterinarians are cautiously optimistic, concerned about accuracy and breed-specific customisation.
- **Interpretation:** Enhancing AI credibility is crucial. The app should ensure scientific accuracy and reliable customisation, build trust through transparent functionalities, and clearly communicate its capabilities.

4. Calorie Control Challenges:

- **Findings:** Both groups identify overfeeding and calorie management as major issues.
- **Interpretation:** The app should focus on effective calorie control tools, providing better portion management and nutritional balance to support healthier feeding practices.

This integrated analysis validates the research objectives, guiding the development of Pawfect Diet. Key focuses are personalised plans, educational features, reliable AI, and effective calorie control, ensuring the app is advanced, accurate, user-friendly, and aligns technology with practical pet care needs.

4.5 Summary

This chapter analysed survey data from dog owners and veterinarians on canine dietary practices and the potential for AI integration in diet management. Dog owners showed diverse dietary practices, moderate confidence in nutritional knowledge, and a positive attitude towards AI, with a strong interest in Personalised diet plans and calorie tracking. Common challenges identified included managing calorie intake and ensuring balanced diets. Veterinarians highlighted frequent diet-related health issues, emphasising the need for effective dietary tools and cautiously optimistic about AI, stressing the importance of scientifically validated solutions. The cross-analysis revealed a consensus on Personalised dietary plans, identified gaps in digital tool adoption, and underscored the need for accurate, breed-specific AI solutions. Effective calorie control features were also deemed essential. Overall, the findings guide the development of Pawfect Diet, emphasising the need for an AI-driven app that is accurate, user-friendly, and aligned with both owner and veterinary expectations, thereby bridging the gap between innovative technology and practical pet care.

Chapter 5

Design

5.1 Chapter Overview

This chapter explores the comprehensive design strategies implemented in the development of the application. It aims to demonstrate how research findings inform the project and the ways in which both functional and non-functional requirements are integrated to enhance user experience and system functionality. Additionally, this chapter discusses the significance of design principles and usability goals within a human-centred approach, illustrating their application through examples of low and high-fidelity prototypes.

5.2 Requirements Specification

This section outlines the comprehensive requirements specifications for the Pawfect Diet app, specifically designed to support dog owners in managing their pets' nutritional needs effectively. The specifications are categorised into functional and non-functional requirements to ensure a holistic development approach, covering all aspects of the application's performance and usability. Both requirements are driven by the research finding outlined in chapter 4.

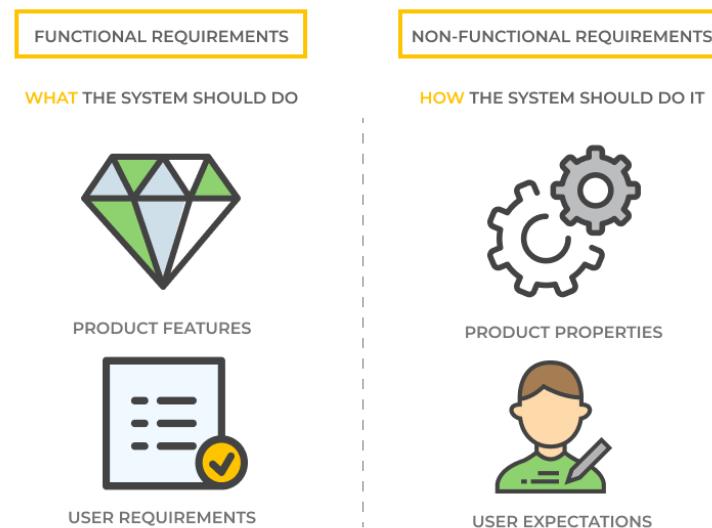


Figure 5. 1 - Functional vs Non-Functional Requirements

5.2.1 Functional Requirements

The functional requirements detail the essential actions and features that the Pawfect Diet app must support to effectively meet the diverse needs of its users. These requirements were meticulously developed through a synthesis of user feedback and the research findings detailed in Chapter 4. Each requirement is vital for ensuring that the app not only delivers a personalised user experience but also engages users in a meaningful way (P. A. Laplante, M. Kassab, 2022). The following table outlines the specific functional requirements identified for the Pawfect Diet app.

ID	Requirement Statement	Must/Want	Comments
FR001	The mobile application shall include a login and registration page for user authentication.	Must	Essential for securing user data and personalising the experience.

FR002	The mobile application shall allow users to create and manage an unlimited number of dog profiles.	Must	Essential for users with multiple pets; enhances app usability by accommodating all user dogs.
FR003	The mobile application shall prompt users to enter health information during the dog profile creation process.	Must	Crucial for tailoring dietary plans to each dog's health needs, ensuring Personalised and effective management.
FR004	The mobile application shall allow users to use breed recognition to confirm or identify their dog's breed.	Want	Useful for users unsure of their dog's breed, enhancing dietary personalisation by confirming breed accuracy.
FR005	The mobile application shall enable users to personalise dog profiles with profile pictures and tag lines.	Want	Adding profile pictures and tag lines boosts user engagement and visual appeal, though not critical for basic functionality.
FR006	The mobile application shall allow users to switch between multiple dog profiles from the appropriate page.	Must	Essential for users with multiple dogs, enabling seamless management of each pet's profile within the app.
FR007	The mobile application shall restrict access to core functionalities, ensuring users are logged in and have at least one dog profile set up.	Must	This requirement is critical for ensuring that the app delivers Personalised and relevant content to the user.
FR008	The mobile application shall provide navigation tabs to facilitate easy navigation throughout the app.	Must	Navigation tabs are essential for a clear, intuitive user experience, allowing easy movement between app sections and enhancing efficiency.
FR009	The mobile application shall have a dashboard page.	Want	The dashboard is useful for providing quick actions and overview.
FR010	The mobile application shall include a "Feed Log" section where users can manage all dietary logs for their dogs.	Must	The "Feed Log" is crucial for users to track and manage their dogs' dietary intake and activities, supporting detailed record-keeping for health monitoring and diet adjustments.
FR011	The mobile application shall allow users to navigate between calendar days to access past and future feed logs.	Want	Navigating through calendar days is critical for managing and planning feed logs, enhancing user engagement with historical dietary views and future meal planning, ensuring comprehensive tracking.
FR012	The mobile application shall provide a feature that allows users to generate a complete daily dietary and activity plan for their dogs with AI.	Must	This functionality automates the creation of daily plans including meals, treats, and activities tailored to each dog's health and activity levels.
FR013	The mobile application shall enable users to manually manage the feed log by adding and removing meals, treats, and activities.	Must	Enabling manual feed log management is crucial for users who prefer direct customisation of their dog's diet and activity records.
FR014	The mobile application shall provide daily feedback generated by AI.	Must	Offering daily feedback upon log closure is crucial for informing users about their dog's daily intake and activities, providing valuable insights and suggestions for optimising their health and diet.

FR015	The mobile application shall include a feature for tracking daily caloric intake for each dog profile.	Must	Calorie tracking is vital for monitoring a dog's health and dietary needs, ensuring they receive the right number of calories per day based on activity level and health goals.
FR016	The mobile application shall allow users to enter, track, and manage work activities, including the calories burned, for dogs identified as working dogs.	Must	This feature is crucial for working dog owners, offering a tailored approach to managing their unique physical demands and caloric needs.
FR017	The mobile application shall automatically calculate health goals for dogs, such as daily caloric needs and goal weight, based on their profiles.	Must	This feature is vital for giving dog owners precise, scientifically-backed health targets crucial for proper diet and weight management.
FR018	The mobile application shall include a "Vet Care" feature, an AI-powered chat interface where the AI acts as a private vet, providing daily updates and recommendations based on the dog's activities and dietary logs.	Must	The "Vet Care" feature is essential for boosting app interactivity and support by providing personalised veterinary advice.
FR019	The mobile application's "Vet Care" feature shall include an intelligent detection system that identifies key changes or updates mentioned by the user within the chat, prompting the user to confirm if they wish to update the dog's profile accordingly.	Must	Automatically detecting and suggesting updates, the system keeps dog profiles accurate, enhancing app usability for a better user experience.
FR020	The mobile application shall include a menu for additional navigation options within the app's features.	Want	Adding a supplementary menu improves app navigation, giving users another way to access features efficiently.

Table 5. 1 - Functional Requirements Identified for Pawfect Diet

5.2.2 Non-Functional Requirements

Non-functional requirements define the Pawfect Diet app's quality attributes, focusing on reliability, efficiency, and user satisfaction. While not directly influencing app functionalities, they affect performance, usability, security, and scalability, crucial for a seamless user experience (P. A. Laplante, M. Kassab, 2022). The table below lists essential non-functional requirements to ensure the app is effective, secure, and enjoyable.

ID	Requirement Statement	Must/Want	Comments
NFR001	The app should load and respond quickly.	Must	Ensures the app operates smoothly and efficiently, enhancing the user experience.
NFR002	The app interface must be intuitive and easy to navigate.	Must	Essential for user satisfaction and adoption, ensures easy access to all functions without confusion.
NFR003	The mobile application shall be compatible with both Android and iOS devices.	Want	Ensuring compatibility on major mobile platforms broadens app accessibility, reaching a wider audience.
NFR004	The mobile application shall incorporate visually appealing elements to enhance the aesthetic appeal.	Want	Adding attractive visuals can enhance user experience, engagement, and app enjoyment.

Table 5. 2 - Non-Functional Requirements Identified for Pawfect Diet

5.3 User Interaction

With the functional and non-functional requirements firmly established, the next crucial step in the design process for the Pawfect Diet app was to map out how users would interact with the application. A common practice in software engineering, employing a use case diagram helps visualise user interactions clearly. This is followed by designing a screen map, which provides a detailed understanding of the navigation flow within the app (M. Khairat et al., 2022).

5.3.1 Use Case Diagram

This subsection presents a use case diagram that illustrates the various user interactions possible within the Pawfect Diet app. The diagram highlights the functional aspects of the application, showing how users can perform specific tasks and what responses they can expect from the system.

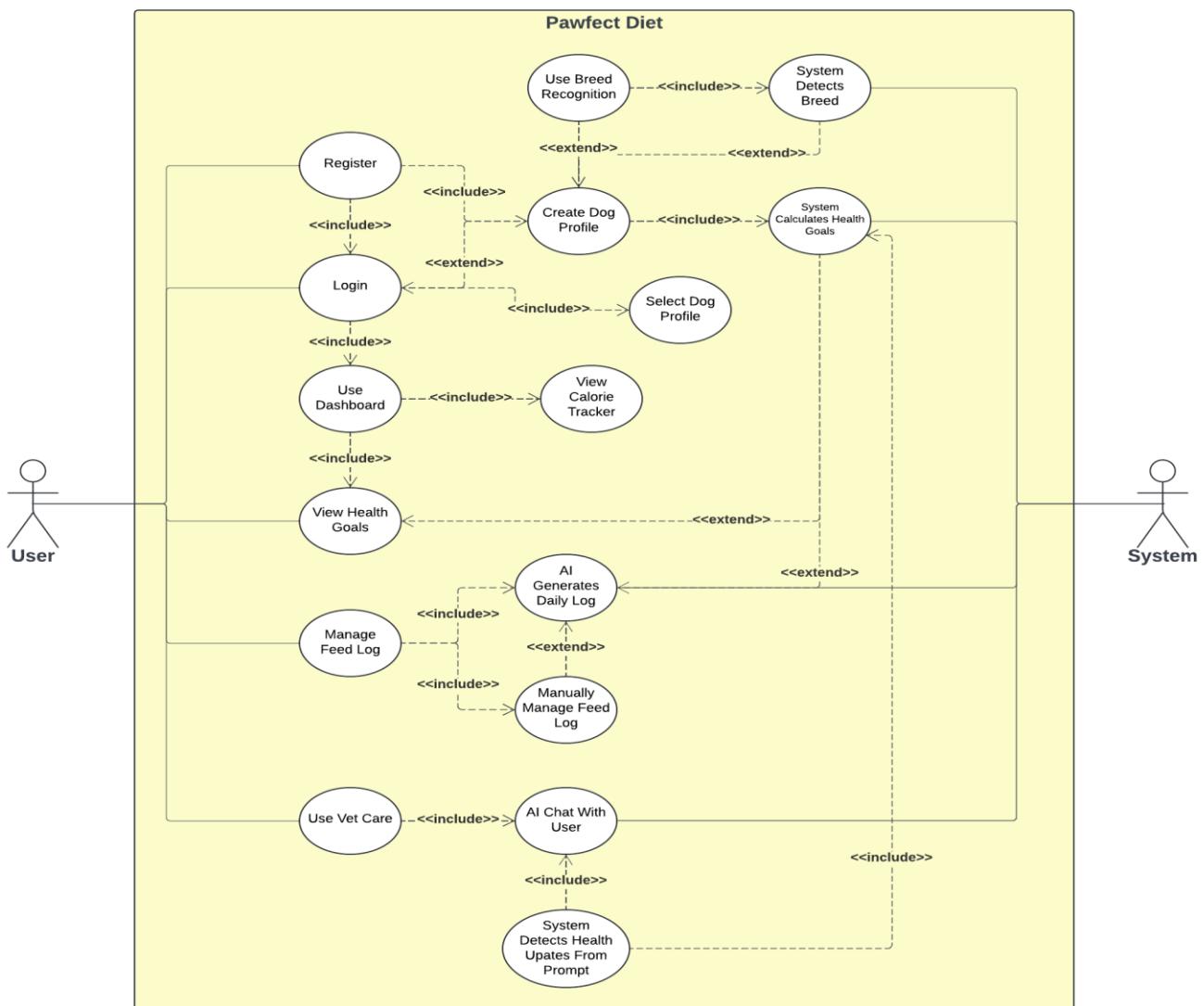


Figure 5. 2 - Use Case Diagram for Pawfect Diet

5.3.2 Navigation Flow

Building on a thorough understanding of the app's functional and non-functional requirements, and guided by a clear conceptualisation of the app's workflow as depicted in the use case diagram (Figure 5.2), the design process focused on developing ten key screens (table 3.2). The flowchart provided below offers an overview of the user journey, illustrating the navigation through the app from initial login to daily interactions. This visual aid enhances the contextual understanding of the screen descriptions and demonstrates the logical progression between screens.

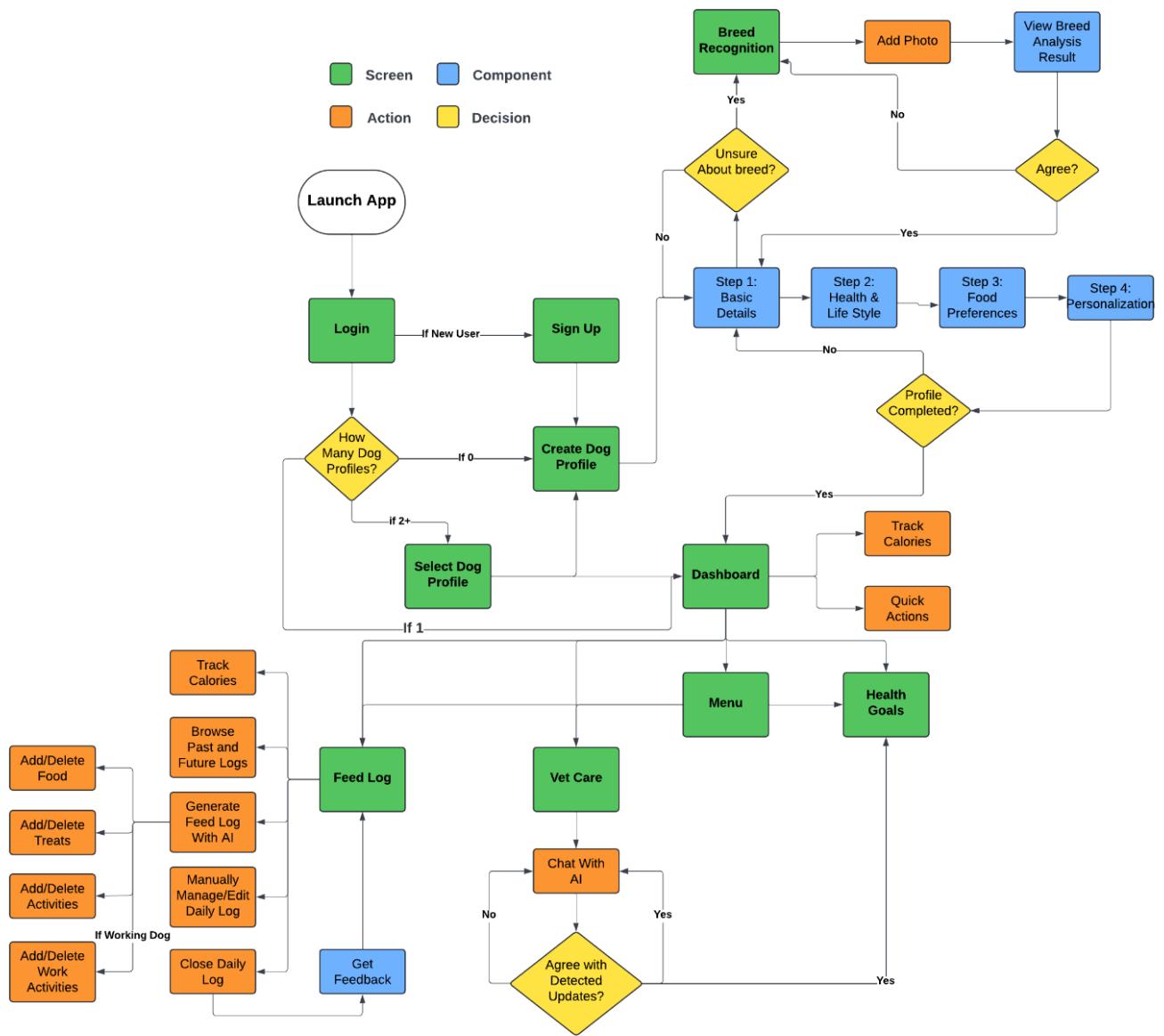


Figure 5. 3 - User Journey and Navigation Flow Chat

5.4 Design Framework and Principles

The Pawfect Diet app's interface design was structured around core interaction design principles, essential for creating intuitive and engaging user experiences (table 5.3), driven by insights from the literature review and user surveys, in which it was underscored that users required a robust system that could handle detailed personalisation for canine diets while being manageable and not

overwhelming. These principles, as defined by Y. Rogers and colleagues (2023), aim to optimise user interactions by making system functions obvious, providing meaningful information back to the user, and ensuring that controls communicate how to use them effectively.

Design Principle	Application in Pawfect Diet	Impact on User Experience
Visibility	Prominent display of navigation tabs and status indicators on every page.	Users can easily see where they are in the app and understand what actions are possible without confusion.
Feedback	Immediate visual and text feedback following user inputs and actions.	Enhances user confidence and reduces errors by confirming actions like profile updates or diet adjustments.
Affordance	Interactive elements such as dropdown menus and intuitive buttons designed to be tactile and easy to manipulate where possible.	Facilitates an engaging interaction, making the app not only functional but also enjoyable to use.

Table 5. 3 - Design Principles Identified for Pawfect Diet

5.4.1 Implementation of Usability Goals

The design of the Pawfect Diet app was meticulously developed to achieve a set of core usability goals: effectiveness, efficiency, utility, learnability, and memorability. These goals, essential for creating a successful user-centred application, were informed by interaction design principles highlighted above (Y. Rogers et al., 2023). Each of these goals addresses specific aspects of the user interaction, from the initial engagement with the app to the retention of information for future use. By strategically implementing these usability objectives, the app aims to deliver a comprehensive and intuitive user experience that caters to a wide range of user needs and preferences. The detailed strategies and their impacts on user experience are summarised in the table below.

Usability Goal	Implementation Strategy	Impact on User Experience
Effectiveness	Ensured all user interactions resulted in meaningful outcomes, such as providing accurate dietary recommendations based on comprehensive dog profiles.	Increases user trust in the app's recommendations and enhances overall satisfaction.
Efficiency	Streamlined navigation paths and minimised the number of steps required to perform tasks.	Reduces user effort and time spent on tasks, leading to a smoother and faster user experience.
Utility	Integrated features like customisable diet plans that adapt to different dog profiles and health needs.	Ensures the app meets diverse user needs, increasing its practical value and daily usability.
Learnability	Designed intuitive user interfaces and interactions that new users could easily understand and use.	Facilitates a quick and easy learning curve, allowing users to become proficient with the app more rapidly.
Memorability	Used consistent UI elements across different sections and functionalities of the app.	Helps users remember how to use the app effectively, even if they return after a period of non-use.

Table 5. 4 - Human-Centric Usability Goals identified for Pawfect Diet

5.4.2 Prototyping

After defining the requirements and adopting a human-centred approach with clear usability goals and design principles, the next step was to develop the user interface. The methodology followed a straightforward and traditional approach, progressing from low-fidelity prototypes (sketches) to high-fidelity prototypes (detailed UI design).

This section presents a few examples comparing low and high-fidelity prototypes shared with participants for feedback. It's important to note that the design process was comprehensive, covering all previously mentioned screens. The examples provided here are a representative sample.

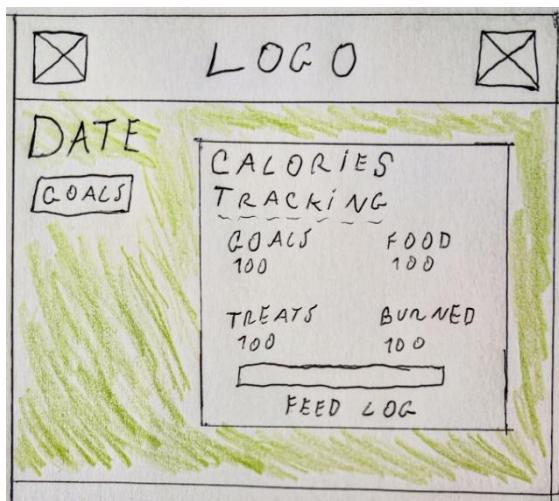


Figure 5. 4 - Low-Fidelity Prototype of the Calorie Tracker in the Dashboard Screen

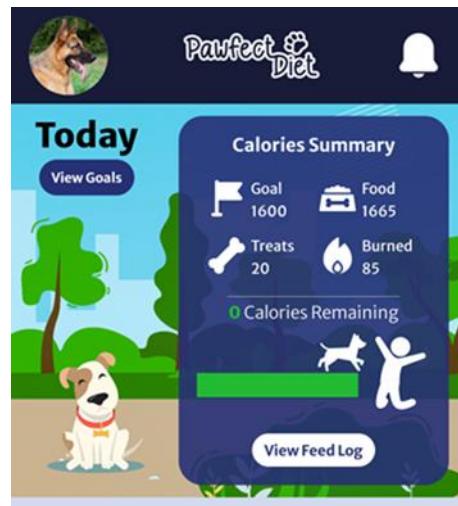


Figure 5. 5 - High-Fidelity Prototype of the Calorie Tracker in the Dashboard Screen

Figures 5.4 and 5.5 display the Calories Tracker within the dashboard, exemplifying how the design adheres to the core principles of visibility and affordance. The interface balances simplicity with playful elements, effectively enhancing user engagement and meeting our usability goals of efficiency and learnability.

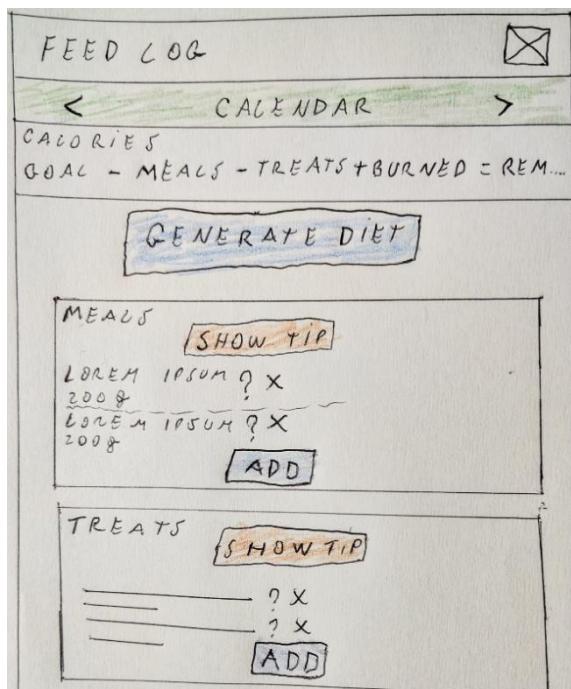


Figure 5. 7 - Low-Fidelity Prototype of Feed Log Screen

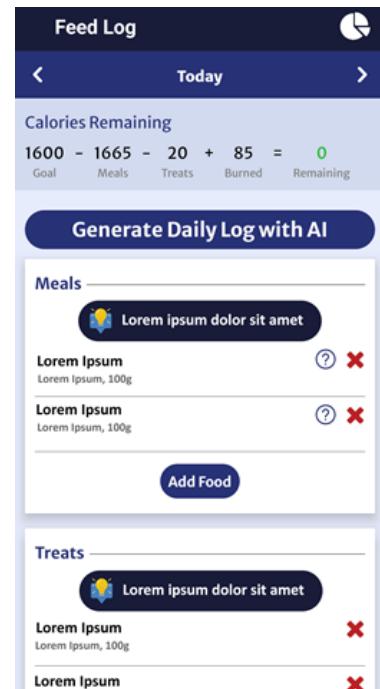


Figure 5. 6 - High-Fidelity Prototype of Feed Log Screen

Figures 5.6 and 5.7 display the Feed Log of the Pawfect Diet app, a key feature for creating customised dog diets. This interface demonstrates efficiency and utility by emphasising simplicity. The prominent "Generate Daily Log with AI" button and clearly visible manual interaction options

streamline diet creation, enhancing usability and engagement by adhering to design principles of visibility, affordance, and clear feedback.

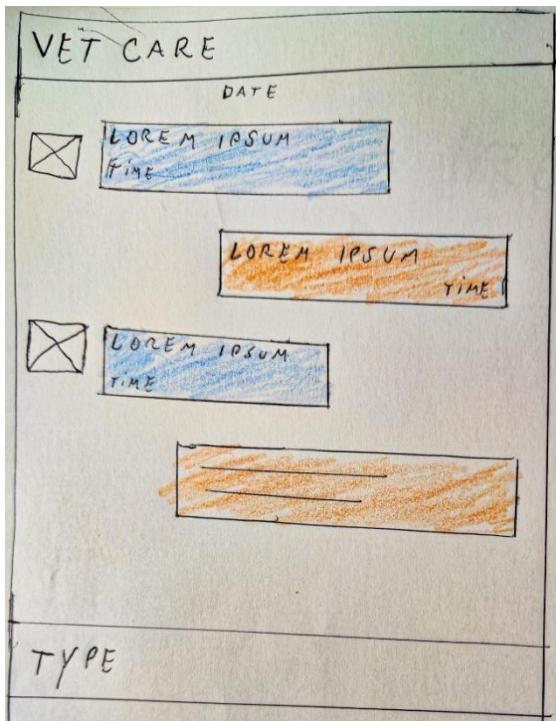


Figure 5.9 - Low-Fidelity Prototype of Vet Care Screen



Figure 5.8 - High-Fidelity Prototype of Vet Care Screen

Figures 5.8 and 5.9 highlight the Vet Care chat interface of the Pawfect Diet app, which simulates veterinary consultations to improve user interaction. The design emphasises visibility and immediate feedback, ensuring messages and commands are clear and the information flow is continuous. This approach enhances efficiency and effectiveness, simplifying complex consultations into user-friendly interactions that enhance both functionality and user satisfaction.

The designs illustrated above represent only a subset of the application's key screens and functionalities. The same logic and principles applied here are consistently used across all screens to ensure a user-friendly and engaging interface. While it is too early to discuss the implementation of functional requirements, the design phase clearly integrates non-functional requirements. For example, NFR002 and NFR004, which emphasise an intuitive, easy-to-navigate interface and the inclusion of playful elements, are evident in the design.

5.5 Summary

The design chapter comprehensively outlines the systematic approach taken in crafting the Pawfect Diet app. It details how the functional and non-functional requirements are meticulously translated into a user-centric interface, ensuring an optimised user experience and efficient application performance. The chapter demonstrates the integration of design principles and usability goals through sections on user interaction design and requirements specification, each underpinned by thorough research and practical implementation strategies. Prototyping sections illustrate the evolution of the app from initial concepts to refined interfaces, showcasing the effective application of design theories in practical scenarios.

Chapter 6

Implementation

and Testing

6.1 Chapter Overview

This chapter delineates the comprehensive implementation of the Pawfect Diet app, highlighting key development stages, integration of artificial intelligence functionalities, and user interface execution. The chapter presents a detailed examination of the technological stack, including the use of React Native Expo for app development and Firebase for robust backend support. It discusses the integration of advanced AI capabilities using GPT-3.5 Turbo for personalised diet recommendations and TensorFlow for breed recognition. Additionally, the chapter elaborates on architectural design and the rigorous testing protocols applied to ensure the app's functionality and user experience are optimal.

6.2 React Native and Dependencies

To meet the non-functional requirement (NFR003) that Pawfect Diet must be compatible with both Android and iOS devices, the app was developed using React Native Expo. This JavaScript framework extends React.js to target mobile platforms, allowing cross-platform compatibility through Babel, which converts JavaScript syntax into native code. The choice to use Expo for development was driven by its simplicity and efficiency in managing project builds (Expo).

React Native does not use CSS for styling; instead, it utilises Flexbox layout by default, with styles defined directly in JavaScript. Visual Studio Code was selected as the IDE to enhance the development process with its extensive personalisation options through extensions.

Given the complex front-end and back-end requirements of Pawfect Diet, several key dependencies were integrated (figure 6.1):

- **Expo Packages:** Key packages like expo-file-system, expo-image-picker, and expo-secure-store enabled access to native device functionalities such as file storage, media library, and secure storage. For instance, expo-image-picker was essential for features requiring photo uploads, such as breed recognition and profile personalisation (Expo).
- **React Navigation:** Employed to manage in-app navigation, providing a seamless user experience across screens and tabs. This library facilitated the development of an intuitive navigation structure, ensuring smooth transitions and a coherent user journey throughout the app (React Navigation).
- **TensorFlow:** Allows machine learning integration, specifically used for the breed recognition model in Pawfect Diet, enabling advanced image recognition features within the application (TensorFlow).
- **Firebase:** Utilised for backend services, with modules for authentication, Firestore, and storage managed through the firebase package, supporting

```
dependencies: {
  "@expo/metro-runtime": "~3.1.3",
  "@expo/webpack-config": "~19.0.1",
  "@react-native-async-storage/async-storage": "1.21.0",
  "@react-native-community/datetimepicker": "7.6.1",
  "@react-navigation/bottom-tabs": "^6.5.16",
  "@react-navigation/native": "6.1.10",
  "@react-navigation/native-stack": "6.9.22",
  "@tensorflow-models/mobilenet": "2.1.1",
  "@tensorflow/tfjs": "4.17.0",
  "@tensorflow/tfjs-react-native": "1.0.0",
  "date-fns": "3.6.0",
  "decode-uri-component": "0.4.1",
  "expo": "50.0.6",
  "expo-app-loading": "2.1.1",
  "expo-auth-session": "5.4.0",
  "expo-blur": "12.9.2",
  "expo-crypto": "12.8.1",
  "expo-file-system": "16.0.8",
  "expo-font": "11.10.3",
  "expo-image-picker": "14.7.1",
  "expo-permissions": "14.4.0",
  "expo-random": "13.6.0",
  "expo-secure-store": "12.8.1",
  "expo-updates": "0.24.12",
  "expo-web-browser": "12.8.2",
  "firebase": "10.8.0",
  "query-string": "8.2.0",
  "react": "18.2.0",
  "react-dom": "18.2.0",
  "react-native": "0.73.6",
  "react-native-chart-kit": "6.12.0",
  "react-native-circular-progress": "1.3.9",
  "react-native-confetti-cannon": "1.5.2",
  "react-native-dotenv": "3.4.10",
  "react-native-eject": "0.2.0",
  "react-native-fs": "2.20.0",
  "react-native-gifted-chat": "2.4.0",
  "react-native-image-picker": "7.1.0",
  "react-native-safe-area-context": "4.8.2",
  "react-native-svg": "14.1.0",
  "react-native-toast-message": "2.2.0",
  "react-native-vector-icons": "10.0.3",
  "react-native-web": "0.19.6"
}
```

Figure 6. 1 - List of software dependencies utilised in the development of the Pawfect Diet app

data storage and user management. This integration streamlined user authentication processes and ensured robust data handling and storage solutions (Google).

- **Additional UI Libraries:** Libraries like react-native-chart-kit, react-native-circular-progress, and react-native-gifted-chat enhanced UI elements and data visualisation. For example, react-native-gifted-chat significantly expedited the development of the Vet Care Chat feature's front end, enabling real-time, interactive communication within the app (Expo).

This paper does not delve deeply into Firebase integration, as the primary focus is to explore how AI can assist dog owners. However, it is important to acknowledge that the database structure was carefully considered and equally emphasised during development. The Database is structured as shown in **figure 6.2**, and the app successfully performs CRUD operations across various components calling at services mentioned above.

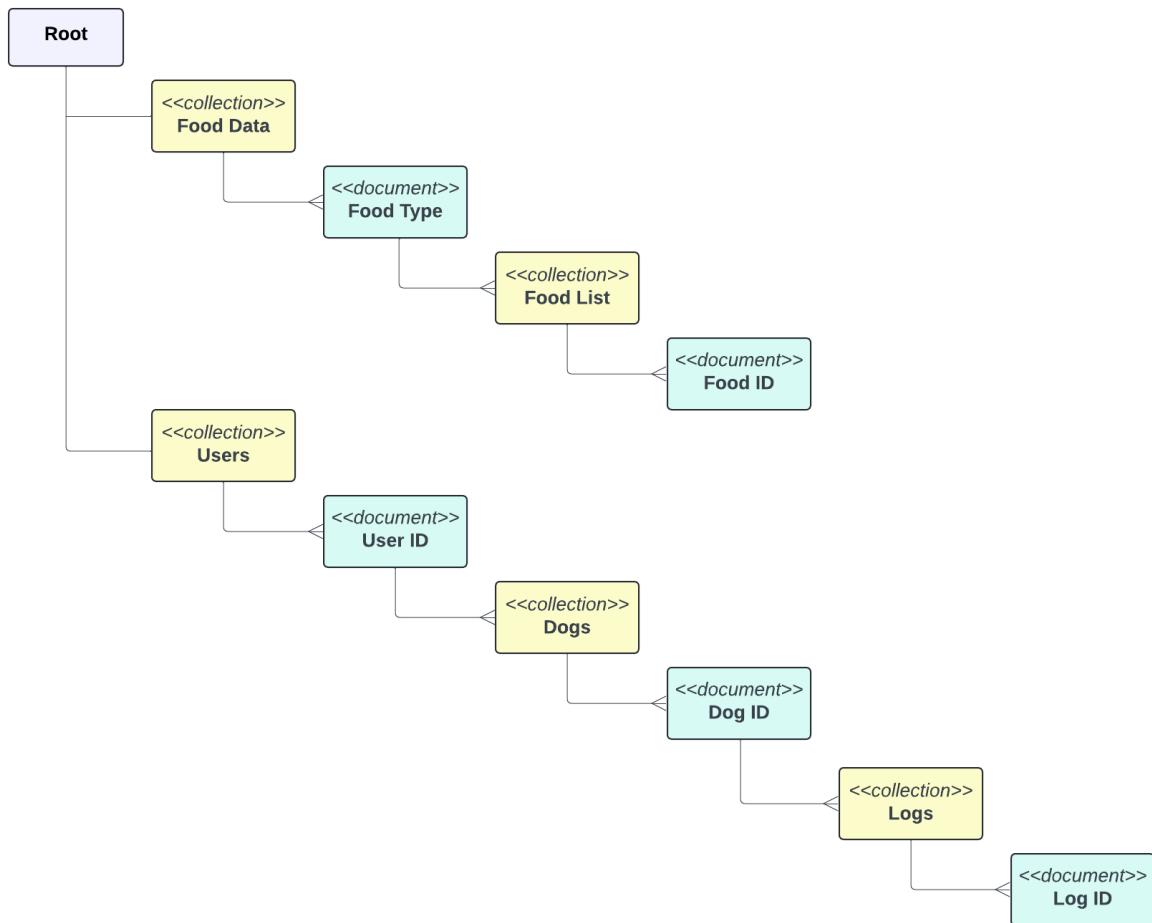


Figure 6. 2 - Database schema diagram for the Pawfect Diet app showing the Firebase data model structure.

6.2.1 Front-End Development

Front-end development was pivotal in ensuring that Pawfect Diet is not only functional but also enjoyable to use. React Native's component-based structure facilitates a modular approach to UI development, where complex sections are broken down into manageable components. This modularity simplifies creating reusable elements like buttons and input fields, and the inherent use of Flexbox aids in responsive design (Expo).

The project structure adheres to best development practices, organising content within a “src” folder subdivided into subfolders such as “screens” and “components”. This organisation enhances maintainability and scalability, crucial for future enhancements. The complete front-end source code is available through the GitHub link in the appendix.

This streamlined approach to development, coupled with strategic use of dependencies, ensures that Pawfect Diet effectively merges technology with user-centric design, making advanced AI features accessible and practical for everyday pet care.

```
<InputWithIcon
  iconName="email"
  iconType="Fontisto"
  placeholder="Email"
  onChangeText={(text) => setEmail(text)}
/>
<InputPassword
  placeholder="Password"
  isPassword={true}
  onChangeText={(text) => setPassword(text)}
/>
<ButtonLarge
  buttonName="LOGIN"
  isThereArrow={true}
  onPress={handleLogin}
/>
```

Figure 6.3 - Example of Reusable Components Constructed in React Native while Developing Pawfect Diet

6.3 App Architecture

The high-level architecture of the Pawfect Diet app is designed to integrate various functionalities seamlessly, leveraging both cloud-based and local resources. The architecture is divided into three main layers: User Interface, Logic, and Data Storage.

- **User Interface:** This layer comprises the various screens and components that the user interacts with.
- **Logic:** This layer handles the business logic and integrates with AI and ML models.
- **Data Storage:** This layer manages data persistence and retrieval using Firebase.

The system architecture diagram, figure 6.4, illustrates the interaction between the components:

- User interfaces interact with Firebase for data storage and retrieval.
- API calls to the GPT-3.5 Turbo model handle AI functionalities.
- Local TensorFlow/Teachable Machine models process images for breed recognition.

The data flow within the Pawfect Diet app involves users interacting with the UI to log in, create profiles, update feeding logs, and upload images. User-uploaded images are processed locally by TensorFlow/Teachable Machine models for breed recognition, and inputs related to dog profiles are sent to the GPT-3.5 Turbo model via API for Personalised diet suggestions. User data, including profiles, logs, and health goals, is stored in Firestore, images are uploaded to Firebase Storage, and authentication is managed by Firebase Authentication, with the app retrieving data from Firebase to update the UI and provide real-time feedback.

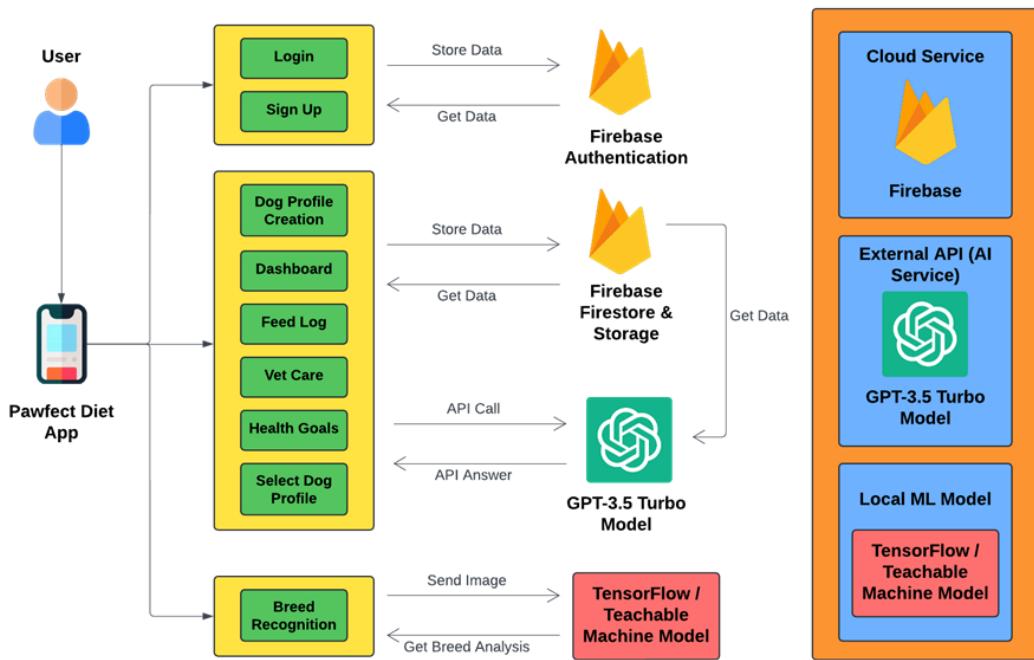


Figure 6. 4 - Pawfect Diet Architecture Diagram

6.4 Integration of AI

This section details the integration of AI with the GPT-3.5 Turbo model into the Pawfect Diet app, enhancing its functionalities. It covers the configuration of the OpenAI API, techniques for interacting with the AI, methods for handling responses, and addresses model limitations. The app employs strategic methods such as precise prompt engineering, efficient response handling, and supplementary manual calculations to ensure effective communication with the AI and maintain app functionality and reliability. It also demonstrates how AI-generated features are seamlessly integrated into the app's user interface.

6.4.1 API Configuration

The Pawfect Diet app interfaces with OpenAI's API through a secure and streamlined process (figure 6.5). The API key is securely stored and accessed via environment variables to maintain security. The integration involves two key functions: `fetchAISuggestions` and `fetchVetAdvice`, which handle communication with OpenAI's API by performing POST requests to specific endpoints. Each request includes headers with Content-Type set to application/json and an Authorisation token bearing the OpenAI API key, ensuring secure and authenticated interactions (OpenAI).

The API requests are customised with parameters such as prompt for dietary suggestions and messages for vet advice, along with settings like `temperature` and `max_tokens` to control the AI's creativity and response length. This fine-tuning ensures the responses are relevant and fit the app's needs. Robust error handling mechanisms are in place to log errors and inform users of any issues, enhancing reliability and user experience.

```

export const fetchAISuggestions = async (promptText) => {
try {
  const response = await fetch("https://api.openai.com/v1/completions", {
    method: "POST",
    headers: {
      "Content-Type": "application/json",
      Authorization: `Bearer ${OPENAI_API_KEY}`,
    },
    body: JSON.stringify({
      model: "gpt-3.5-turbo-instruct",
      prompt: promptText,
      temperature: 0.5,
      max_tokens: 1000,
    }),
  });

  const data = await response.json();
  if (response.ok) {
    return data.choices[0].text;
  } else {
    throw new Error(data.error.message);
  }
} catch (error) {
  console.error("Error fetching AI suggestions:", error);
  throw error;
}
};

export const fetchVetAdvice = async (conversationHistory) => {
try {
  const response = await fetch("https://api.openai.com/v1/chat/completions", {
    method: "POST",
    headers: {
      "Content-Type": "application/json",
      Authorization: `Bearer ${OPENAI_API_KEY}`,
    },
    body: JSON.stringify({
      model: "gpt-3.5-turbo-1106",
      messages: conversationHistory,
      temperature: 0.9,
      max_tokens: 200,
    }),
  });

  const data = await response.json();
  if (response.ok) {
    const lastMessage =
      data.choices[data.choices.length - 1].message.content.trim();
    return lastMessage;
  } else {
    throw new Error(data.error.message);
  }
} catch (error) {
  console.error("Error fetching vet advice:", error);
  throw error;
}
};

```

Figure 6. 5 - Sample code snippets demonstrating API calls to OpenAI for fetching AI suggestions and vet advice using React Native

6.4.2 Interaction and Result

Interacting with AI in the Pawfect Diet app involves two key processes: prompt engineering and response handling. These processes are tailored to fit the specific functionalities of the app, particularly in the Feed Log and Vet Care features.

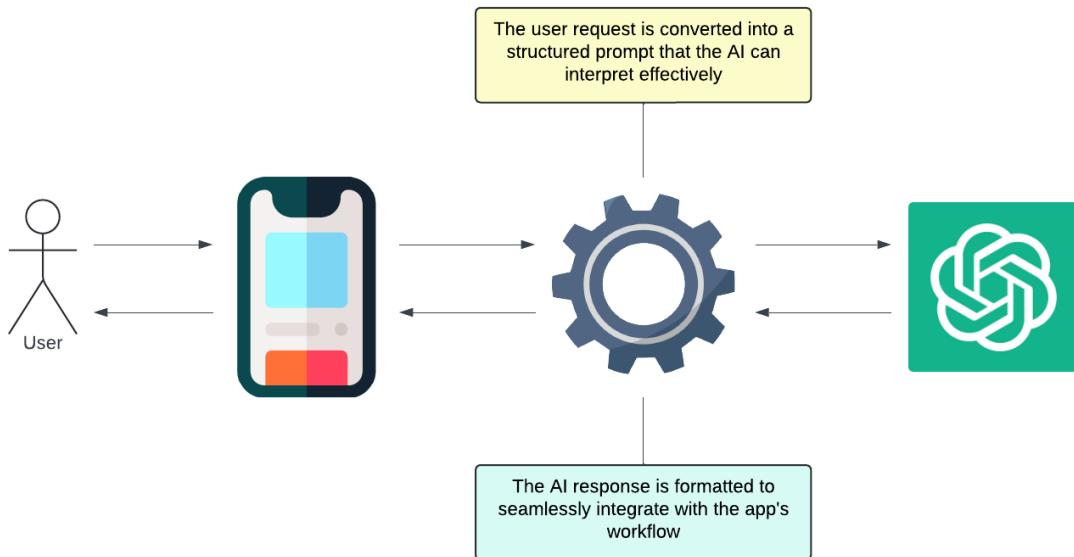


Figure 6. 6 - Diagram showing the process of user interaction with AI: converting user requests into structured prompts and formatting AI responses for the app's workflow.

Prompt engineering is essential for translating user inputs into a format that AI can effectively process and respond to. This technique ensures that the AI understands the context and purpose of the query, enabling it to generate relevant and actionable responses (AWS, 2023).

For generating daily meal plans and closing daily logs in the Feed Log Screen, prompts are structured to request JSON-formatted responses from the AI. This format is chosen to facilitate easy integration and manipulation within the app's workflow. Below, an example demonstrates structuring a prompt to generate a detailed daily meal plan for a dog in the specified JSON format. However, please note that in a real scenario, information such as the dog's details should be dynamically incorporated into a function.

Given the information about the dog, the available food and treats, and the available physical activities listed below, generate a daily meal plan as a JSON object with keys 'food', 'treats', 'activities', 'work', considering also any sub-keys as shown in the example below.

Dog Info:

- Name: Max
- Breed: German Shepherd
- Age: 5 years
- Gender: Male
- Is this dog a working/sporting dog? Yes
- Type of working/sporting: Service
- Current Weight: 30 kg
- Goal Weight: 28 kg
- Overall Goal: Weight loss
- Activity Level: High
- Goal Daily Calories: 1600 kcal
- Goal Daily Proteins: 140 g
- Goal Daily Carbs: 200 g
- Goal Daily Fat: 70 g
- Suggested meals per day: 3

List of food available:

- Brand A - Chicken Breast, Nutritional Info: (Protein: 25%, Carbs: 0%, Fat: 2%)
- Brand B - Turkey with Sweet Potatoes, Nutritional Info: (Protein: 20%, Carbs: 10%, Fat: 5%)

List of treats available:

- Brand X - Meat Sticks, Nutritional Info: (Calories Per Piece: 30, Protein: 20%, Carbs: 50%, Fat: 5%)

List of physical activities available: "Walking", "Running", "Fetch", "Swimming", "Agility Training"

Example of output:

```
food: [{foodBrand: Brand A, foodName: Chicken Breast, note: High protein content suitable for weight loss}]  
treats: [{treatBrand: Brand X, treatName: Meat Sticks, numberOfTreatsPerDay: 2}]  
activities: [{name: Running, durationInMinutes: 30}, {name: Fetch, durationInMinutes: 20}]  
work: [{workType: service, shiftLengthHours: 2, workIntensity: Light}]
```

Table 6. 1 - Example of Prompt Engineering for AI-Driven Daily Meal Plan Generation

Upon receiving the response, the app parses the JSON string to convert it into a usable JavaScript object. This is achieved using `JSON.parse()`, which transforms the string into an object that the app can manipulate and display.

```

const aiResponseString = await fetchAISuggestions(personalisedPlanAI);
console.log("AI Response: ", aiResponseString); // Debugging

const aiResponse = JSON.parse(aiResponseString);
console.log("Formatted AI Response: ", aiResponse);

```

LOG AI Response:

```

{
  "food": [
    {
      "foodBrand": "Tesco",
      "foodName": "Chicken Breast",
      "note": "High in protein and low in carbs, this food is perfect for helping Tony reach his goal weight and maintain a healthy muscle mass."
    },
    {
      "foodBrand": "Pedigree",
      "foodName": "High Protein Beef & Vegetables",
      "note": "This food is also high in protein and will provide Tony with the energy he needs for his intense activity level."
    },
    {
      "foodBrand": "Forthglade",
      "foodName": "Turkey with Sweet potatoes",
      "note": "This food is high in protein and carbs, which will provide Tony with the necessary nutrients for his intense activity level."
    }
  ],
  "activities": [
    {"durationInMinutes": 45, "name": "Running"}, {"durationInMinutes": 30, "name": "Agility Training"}],
  "food": [{"foodBrand": "Tesco", "FoodName": "Chicken Breast", "note": "High in protein and low in carbs, this food is perfect for helping Tony reach his goal weight and maintain a healthy muscle mass."}, {"foodBrand": "Pedigree", "foodName": "High Protein Beef & Vegetables", "note": "This food is also high in protein and will provide Tony with the energy he needs for his intense activity level."}, {"foodBrand": "Forthglade", "FoodName": "Turkey with Sweet potatoes", "note": "This food is high in protein and carbs, which will provide Tony with the necessary nutrients for his intense activity level."}],
  "treats": [{"numberOfTreatPerDay": 2, "treatBrand": "Orlando", "treatName": "Beef Bones"}, {"numberOfTreatPerDay": 1, "treatBrand": "Pedigree", "treatName": "Beef Mini Rolls"}],
  "work": [{"caloriesConsumed": 180, "shiftLengthHours": 3, "workIntensity": "Intense", "workType": "Athletic and Agility Competitions"}]
}

```

Formatted AI Response: {"activities": [{"durationInMinutes": 45, "name": "Running"}, {"durationInMinutes": 30, "name": "Agility Training"}], "food": [{"foodBrand": "Tesco", "FoodName": "Chicken Breast", "note": "High in protein and low in carbs, this food is perfect for helping Tony reach his goal weight and maintain a healthy muscle mass."}, {"foodBrand": "Pedigree", "foodName": "High Protein Beef & Vegetables", "note": "This food is also high in protein and will provide Tony with the energy he needs for his intense activity level."}, {"foodBrand": "Forthglade", "FoodName": "Turkey with Sweet potatoes", "note": "This food is high in protein and carbs, which will provide Tony with the necessary nutrients for his intense activity level."}], "treats": [{"numberOfTreatPerDay": 2, "treatBrand": "Orlando", "treatName": "Beef Bones"}, {"numberOfTreatPerDay": 1, "treatBrand": "Pedigree", "treatName": "Beef Mini Rolls"}], "work": [{"caloriesConsumed": 180, "shiftLengthHours": 3, "workIntensity": "Intense", "workType": "Athletic and Agility Competitions"}]}

Figure 6. 7 - Code snippet showing the parsing of AI-generated JSON responses for dietary suggestions in the Pawfect Diet app

Once the AI response is formatted, essential data can be extracted from the JavaScript object for display on the front-end. Image 6.8 below illustrates the user interface showcasing the AI-driven features, including the daily log and feedback generated by the AI. This information is presented in a user-friendly and easily understandable format, providing valuable insights and feedback to the user.

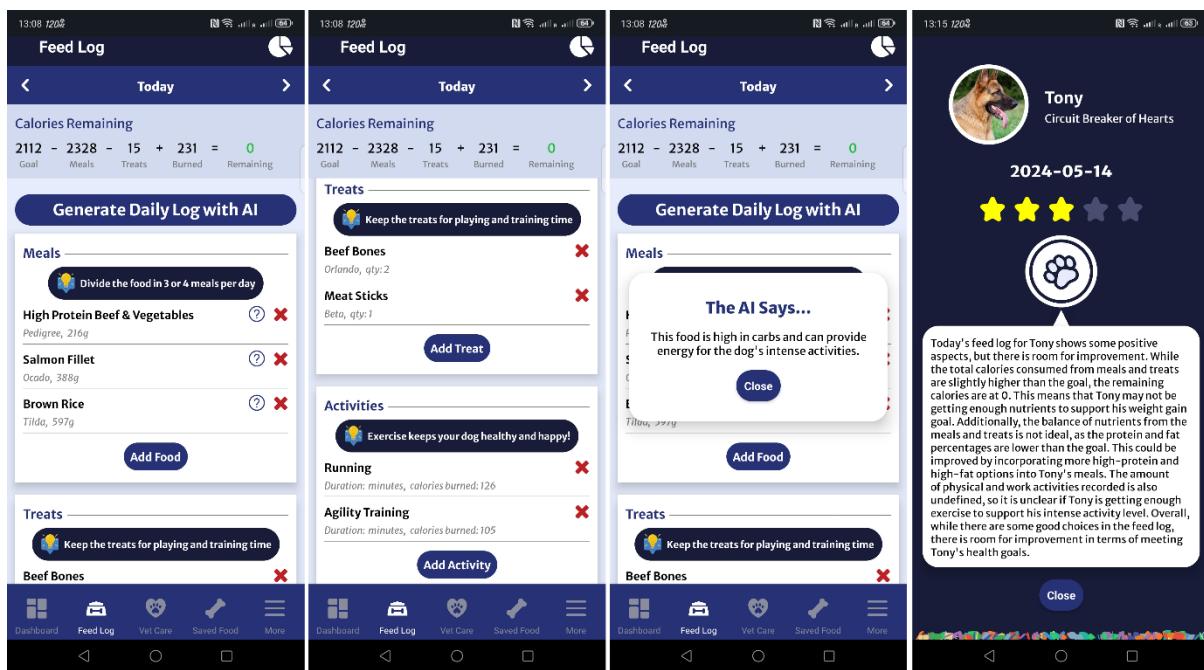


Figure 6. 8 - Screenshot sequence displaying the Feed Log interface in the Pawfect Diet app. The screens illustrate how the app presents daily nutritional tracking, including AI-generated meal recommendations and feedback.

In the Vet Care feature, prompt engineering adopts a conversational approach, designed to mimic real-time veterinary consultations. The AI is informed of the dog's health goals, basic profile information, and any relevant details from ongoing daily logs. This setup allows the AI to generate responses in natural language, creating a more authentic and interactive user experience.

You are Vet BOT, an AI designed to behave like a vet and give advice based on the dog's profile, health goals, and daily intake information provided below. Answer the user's queries naturally and concisely, using the specific information when relevant.

Table 6. 2 - Example of Prompt Engineering for Vet Care Chat

To ensure continuity and relevance, the system meticulously stores conversation histories, enabling the AI to access past interactions and provide contextually relevant responses. This is essential for simulating realistic veterinary consultations where continuity of information is crucial.

The system manages user inputs by recording each new message into the conversation history, which the AI uses to generate appropriate responses. The backend code processes these inputs, ensuring accurate recording and dynamic tailoring of the AI's responses to maintain an ongoing dialogue. This method seamlessly integrates the AI's responses back into the chat interface, allowing users to experience a fluid conversation similar to interacting with a human vet.

```
const onSend = useCallback(
  async (messages = []) => {
    setIsAITyping(true);
    const userMessageText = messages[0].text;
    const newUserMessage = {
      role: "user",
      content: userMessageText,
    };
    let updatedConversationHistory = [...conversationHistory];
    updatedConversationHistory.push(newUserMessage);
    try {
      const aiResponse = await fetchVetAdvice(updatedConversationHistory);
      const aiMessage = {
        _id: Math.random().toString(36).substring(7),
        text: aiResponse,
        createdAt: new Date(),
        user: {
          _id: 2,
          name: "VetBot",
        },
      };
      setMessages((previousMessages) =>
        GiftedChat.append(previousMessages, [aiMessage])
      );
      setConversationHistory([
        ...updatedConversationHistory,
        { role: "assistant", content: aiResponse },
      ]);
      setIsAITyping(false);
    } catch (error) {
      console.error("Failed to fetch AI response:", error);
      setIsAITyping(false);
    }
  },
  [conversationHistory, setIsAITyping]
);
```

Figure 6. 9 - Code snippet showing conversation history management in the Vet Care feature, detailing how user messages are processed and AI responses integrated

In addition to simulating real-time consultations, the Vet Care feature of the app includes an advanced capability that utilises Natural Language Processing (NLP) techniques to detect specific changes mentioned by users during their conversations. For instance, when users mention updates about their dog's weight, the system recognises these statements using a series of regular expressions (figure 6.10). This detection triggers a prompt asking the user if they wish to update their dog's profile with the new weight. This feature not only enhances user interaction but

```
const patterns = [
  /weight of the dog to (\d+)\s*(?:kg)?/i,
  /dog's weight to (\d+)\s*(?:kg)?/i,
  /dog weighs? (\d+)\s*(?:kg)?/i,
  /dog's weight? (\d+)\s*(?:kg)?/i,
  /dog is now (\d+)\s*(?:kg)?/i,
  /dog's weight changed.*? to (\d+)\s*(?:kg)?/i,
  /make the dog weigh (\d+)\s*(?:kg)?/i,
  /set the dog's weight to (\d+)\s*(?:kg)?/i,
  /update the dog's weight to (\d+)\s*(?:kg)?/i,
  /weight to (\d+)\s*/i,
  /weighs? (\d+)\s*/i,
  /weight? (\d+)\s*/i,
  /is now (\d+)\s*/i,
  /changed.*? to (\d+)\s*/i,
];
```

Figure 6. 10 - Code snippet demonstrating the use of regular expressions to detect user-reported changes.

also ensures that the dog's health information remains current, which is critical for providing accurate health advice (C. Roe, 2017).

The screenshots below illustrate the practical application of the Vet Care features, showcasing how user interactions and AI responses are seamlessly integrated into the app's interface.

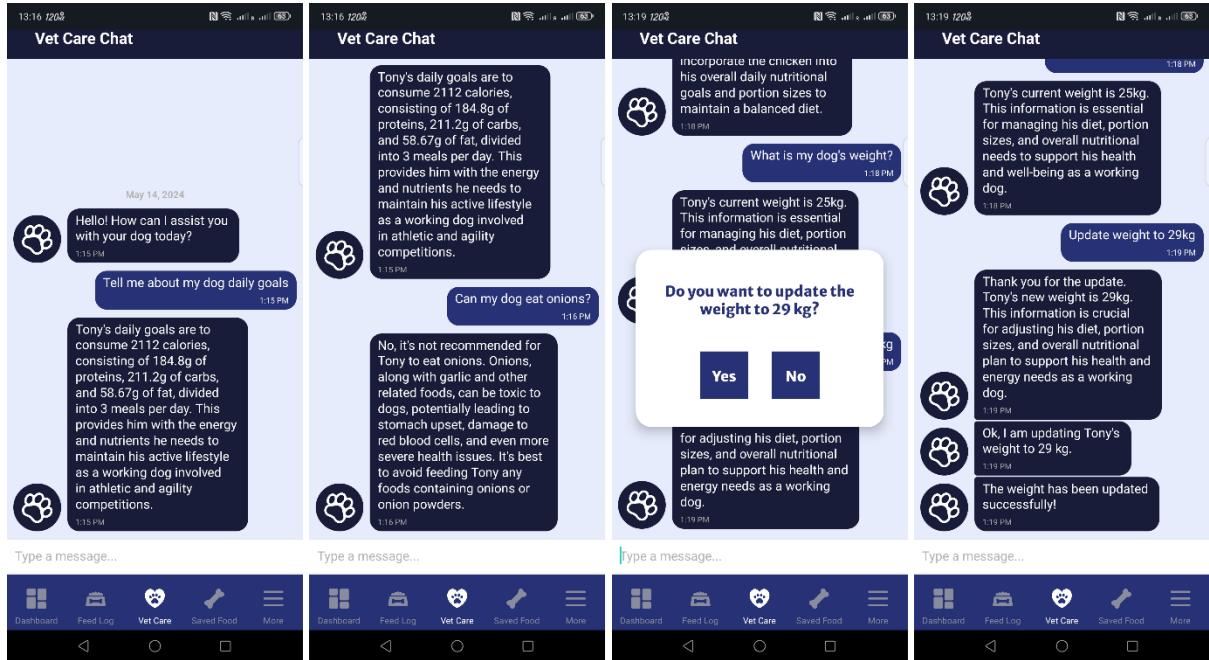


Figure 6. 11 - Screenshots showcasing the Vet Care Chat interface

This section has demonstrated the effective integration of AI within the Pawfect Diet app, detailing the transformation of user inputs into actionable AI responses and their presentation. While still in early stages and subject to further refinement, these functionalities exemplify the potential of AI-driven features to assist dog owners in managing their pets' nutrition comprehensively. It also illustrates the fulfilment of several functional and non-functional requirements outlined in the project, further discussed in Tables 5.1 and 5.2, which highlight the specific requirements achieved through these implementations.

6.5 Calculation of Calories and Health Goals

As highlighted in the methodology chapter, due to limitations of the GPT-3.5 model, calorie calculations and health goal assessments for the Pawfect Diet app are currently performed manually. This approach involves using established veterinary nutritional formulas, ensuring the reliability of the data. However, manual entry is time-consuming and lacks scalability, reason why the current state of the app is designed specifically for Jack Russell Terriers and German Shepherds to demonstrate its capabilities effectively. Future developments will focus on automating these processes to enhance efficiency and broaden the scope.

The primary method for calculating a dog's daily caloric needs is the Resting Energy Requirement (RER), which is based on the dog's weight. The RER formula is widely accepted in veterinary nutrition and serves as a foundational element for calculating the Maintenance Energy Requirement (MER) by applying appropriate factors (V. Pedrinelli et al., 2019).

$$\text{RER (kcal/day)} = 70 \times (\text{body weight in kg})^{0.75}$$

Table 6. 3 - Resting Energy Requirement (RER) Formula

The MER is then adjusted based on factors such as age, activity level, and health status, providing a comprehensive measure for each dog's daily energy needs. Health goals are tailored according to each dog's specific dietary needs and fitness objectives, ensuring personalised and accurate recommendations.

Calculating MER for Dog

Weight(kg)	RER(kcal)	Weight(kg)	RER(kcal)
1	70	21	687
2	118	22	711
3	160	23	735
4	198	24	759
5	234	25	783
6	268	26	806
7	301	27	829
8	333	28	852
9	363	29	875
10	374	30	897
11	423	31	920
12	451	32	942
13	479	33	964
14	507	34	986
15	534	35	1,007
16	560	36	1,029
17	586	37	1,050
18	612	38	1,071
19	637	39	1,092
20	662	40	1,113

*The list above is rounded to the nearest whole number

* RER(kcal)= $70 \times \text{weight} (\text{kg})^{0.75}$

*Calculate RER with ideal weight for weight loss dog

MER Factors

Neutered adult	1.6
Intact adult	1.8
Inactive	1.2 ~ 1.4
Weight loss	1

MER = RER × MER Factors

e.g. An inactive adult 10kg dog

$374 (\text{RER}) \times 1.3 (\text{Factor}) = 486 \text{ kcal}$

A daily calorie intake for 10kg dog
is about 486 kcal

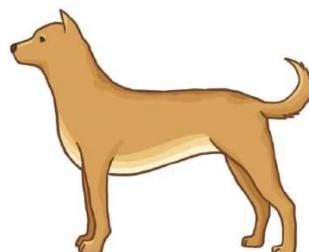


Figure 6. 12 - Table illustrating the calculation of Maintenance Energy Requirements (MER) for dogs based on weight and activity level

6.6 Breed Recognition Development

The breed recognition feature in the Pawfect Diet app utilises Google's Teachable Machine for model development, enabling rapid setup and testing of machine learning capabilities. The model was trained using a comprehensive dataset from Tsinghua University (D. Zou et al., 2020). While the primary focus of the app is on just two breeds as previously mentioned, the model was trained using several breeds to fully test the capabilities of this tool. For training, the model was configured with 50 epochs, a batch size of 16, and a learning rate of 0.001. After training, the model is exported into

TensorFlow.js-compatible files: *model.json*, *weights.bin*, and *metadata.json*, ensuring seamless integration and operation within the app.

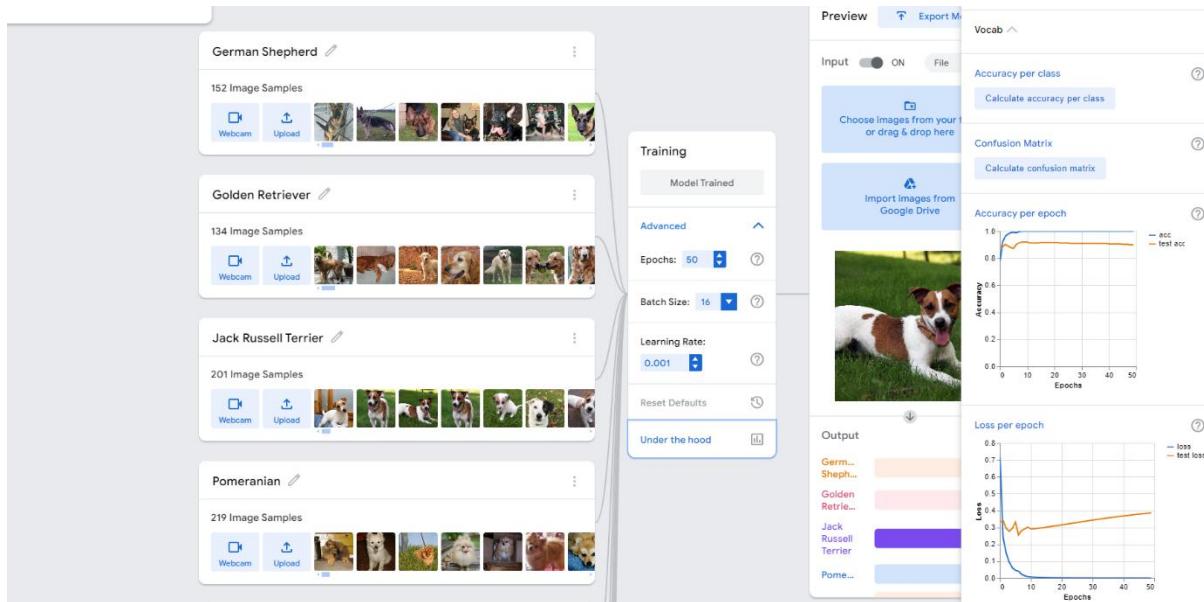


Figure 6. 13 - Teachable Machine interface displaying the training setup and results for a dog breed recognition model.

The React Native component integrates TensorFlow.js to load and run the model on the device:

- Model Loading:** TensorFlow's `tf.loadLayersModel` method is used to read the model files from local storage, ensuring the model is ready for predictions without server fetches.
- Image Processing:** User-uploaded photos are processed into tensors using TensorFlow's image processing functions and fed into the model.
- Prediction and Display:** The model outputs breed probabilities, which are processed to display the most likely breed. The top predictions are shown to the user, providing insights into their dog's breed characteristics.

```
const [model, setModel] = useState(null);

useEffect(() => {
  const loadModel = async () => {
    await tf.ready();
    const modelJson = require("../beedRecognitionModel/model.json");
    const modelWeights = require("../beedRecognitionModel/weights.bin");
    const model = await tf.loadLayersModel(
      bundleResourceIO(modelJson, modelWeights)
    );
    setModel(model);
  };
  loadModel();
}, []);

async function predictImage(imageUrl) {
  if (!model) return;

  const response = await fetch(imageUrl, {}, { isBinary: true });
  const imageData = await response.arrayBuffer();
  const imageTensor = decodeJpeg(new Uint8Array(imageData));
  const processedTensor = imageTensor
    .resizeBilinear([224, 224])
    .expandDims(0)
    .toFloat()
    .div(tf.scalar(255));
  const prediction = await model.predict(processedTensor).data();
  // Processing and setting the prediction result here...
}
```

Figure 6. 14 - Code snippet demonstrating TensorFlow model loading and image prediction in the Breed Recognition feature of the Pawfect Diet app

This integration of TensorFlow.js within the React Native app enables real-time, on-device breed recognition, offering users quick and reliable results directly on their mobile devices.

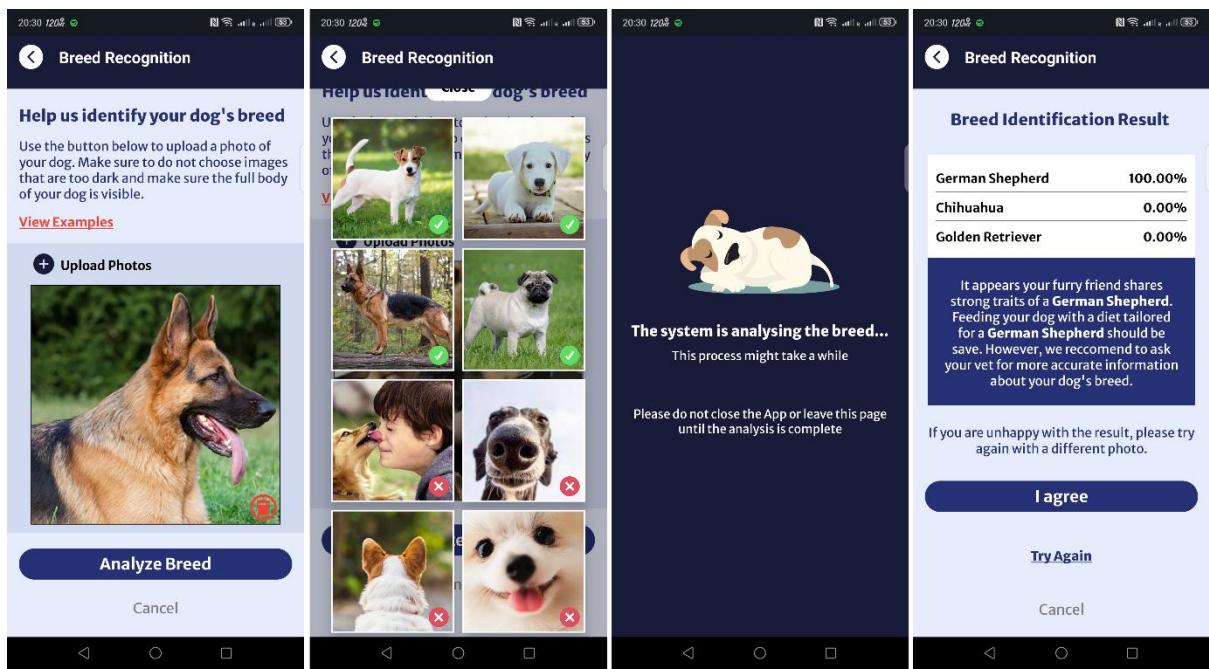


Figure 6. 15 - Screenshots illustrating the Breed Recognition feature in the Pawfect Diet app, from photo upload to the analysis results display

6.7 Testing

Pawfect Diet underwent two types of testing: Unit Testing and Usability Testing (or User Acceptance Testing). This section outlines the approach and results of each test, highlighting any errors, visual bugs, and user feedback.

Please note that, before conducting these tests, the application was thoroughly reviewed to ensure it was feature-complete. However, a visual bug was identified in the calorie trackers of the Dashboard and Feed Log screens, where the numbers temporarily display as NaN before correcting themselves. Due to time constraints, this issue was not resolved but is planned for future investigation.

6.7.1 Unit Testing

Unit testing for Pawfect Diet was conducted using Jest, a widely-adopted testing framework for JavaScript applications. Jest is known for its simplicity, ease of setup, and powerful features like snapshot testing, parallel test execution, and extensive mocking capabilities. These attributes make Jest particularly suitable for testing React Native applications, ensuring reliable and maintainable code by automating the verification of component functionality and logic (Jest Js, 2024).

During unit testing, only one error was identified: In the Feed Log feature, when the user presses “Generate Daily Log with AI”, the operation occasionally fails. This issue is intermittent. Upon investigation, it was determined that the problem stems from how the Firebase call is handled in that specific function, rather than an issue with the AI service.

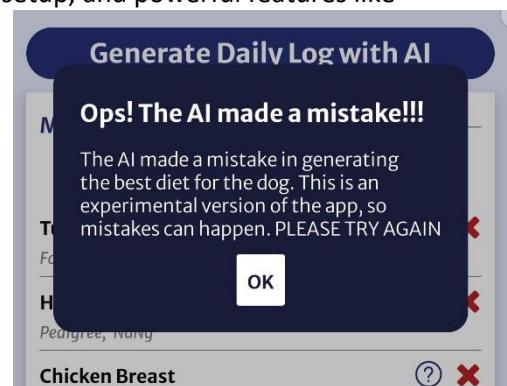


Figure 6. 16 - Error message displayed in the Pawfect Diet app when there is an issue in generating a daily log for a dog

itself. Currently, this error is mitigated by notifying the user of the failure and inviting them to try again. Further investigation and a permanent fix for this issue are planned for future development.

Below is table displaying few outcomes of the unit test results.

ID	Component	Test Description	Expected Outcome	Actual Outcome	Status	Notes
001	Login	User login with correct credentials.	Successfully logs in the user.	Successfully logs in the user.	Pass	
002	Sign Up	User registration with valid data.	Successfully registers a new user.	Successfully registers a new user.	Pass	
003	Dog Profile Creation	Create a new dog profile with required information.	Successfully creates and stores the dog profile.	Successfully creates and stores the dog profile.	Pass	
004	Breed Recognition	Identify dog breed from uploaded photo.	Correct breed identification.	Correct breed identification consistently.	Pass	
005	Feed Log AI Generated Log	Generate Daily Log with AI on button press.	Successfully generate and display the daily log.	Occasionally fails to generate the daily log.	Occasionally Fails	Error due to Firebase call handling. User notified to retry.
006	Feed Log AI Generated Feedback	Generate dietary feedback based on daily log with AI.	Successfully generates dietary feedback.	Successfully generates dietary feedback.	Pass	
007	Vet Care Chat	Process user inputs and generate AI responses in real-time.	AI generates accurate responses based on input.	AI generates accurate responses consistently.	Pass	
008	Switch Dog Profile	Switch between multiple dog profiles.	Correctly switch to and display the selected profile.	Correctly switches to and displays the selected profile.	Pass	

Table 6. 4 - Part of the Unit Test Results for the Pawfect Diet App

6.7.2 Usability Testing

Usability testing involved 22 participants, primarily aged 25-34, evaluating the user experience and AI features of Pawfect Diet. Participants, mostly new to pet diet apps but familiar with AI services, completed tasks such as creating dog profiles, navigating the dashboard, and using the Vet Care chat. They were informed of the app's current focus on Jack Russell Terrier and German Shepherd

breeds and asked to create profiles for various dog types, including female, male, and working dogs, to ensure comprehensive feature testing (see Table 6.5 for a complete list of tasks).

Task Number	Description
1	Navigate from login to sign up
2	Create an account with email and password
3	Create a dog profile (enter basic details, health info, select food preferences, insert profile picture)
4	While creating the profile, use Breed Recognition (upload photo, get analysis and move back to the dog profile creation stage)
5	Visit the dashboard (note: participants were informed this is just a front-end display)
6	Visit Health Goals (from dashboard or navigating in More Menu first and then Health Goals)
7	Navigate to the feed log
8	Manually insert food, treats, activities, and work logs
9	Check out calorie tracker (Visible in dashboard and Feed Log)
10	Delete logs
11	Generate a daily log with AI
12	Close the daily log (receive AI's feedback)
13	Navigate between different dates in feed logs and try to repeat the process
14	Navigate to Vet Care
15	Use the chat function (say anything to test AI responses)
16	Tell the AI in the chat that your dog's weight has changed
17	Accept the changes when prompted
18	Navigate again to Health Goals
19	Navigate to Switch Dog Profile
20	Optionally, create another dog profile with different values
22	Log out
23	Log in again to test the login functionality

Table 6.5 - List of Tasks Given to Participants During Usability Test

Overall, participants found the app easy to navigate, with all rating it as easy or very easy. While most found the profile creation straightforward, a few noted confusions with the food selection process. Satisfaction was high for the calorie tracker and feed log, with 73% and 77% approval, respectively. The AI-generated daily log was considered useful by 77% of users, and the Vet Care chat was rated good or excellent by 91%.

7. How satisfied are you with the calorie tracker feature (Dashboard and Feed Log)?

[More Details](#) Insights

Very satisfied	7
Somewhat satisfied	9
Neither satisfied nor dissatisfied	6
Somewhat dissatisfied	0
Very dissatisfied	0



8. How satisfied are you with the Feed Log feature?

[More Details](#) Insights

Very satisfied	8
Somewhat satisfied	9
Neither satisfied nor dissatisfied	4
Somewhat dissatisfied	1
Very dissatisfied	0



9. How useful did you find the AI-generated daily log?

[More Details](#) Insights

Extremely useful	6
Somewhat useful	11
Neutral	4
Somewhat not useful	1
Extremely not useful	0



Figure 6. 17 - User Satisfaction and Utility Ratings for Key Features in Pawfect Diet App

Trust in the AI was mixed; 55% trusted its recommendations, 36% were uncertain, and 9% did not trust it. The Vet Care chat's detection feature was found useful by 77% of participants. Positive feedback highlighted AI suggestions, ease of use, and comprehensive features. Suggestions for improvement included more accurate calorie tracking, simpler food selection, and options for reporting sickness, which were common themes in open-ended responses.

11. Do you trust the AI's recommendations?

[More Details](#) Insights

Yes	12
No	2
Maybe	8



12. How useful did you find the detection feature for updates within Vet Care?

[More Details](#) Insights

Extremely useful	9
Somewhat useful	8
Neutral	5
Somewhat not useful	0
Extremely not useful	0



Figure 6. 18 - Survey Responses on Trust in AI Recommendations and Utility of Detection Feature in Vet Care

Overall, the usability testing indicated strong potential for Pawfect Diet, with participants rating the overall concept positively, achieving an average rating of 4.27 out of 5. Furthermore, 77% of participants expressed a willingness to use the app regularly for managing their dog's diet, suggesting a favourable reception and a promising future for the application. The feedback obtained

from this usability testing will be instrumental in guiding future developments, ensuring that the app continues to evolve in alignment with user needs and preferences.

6.8 Summary

The chapter concludes by summarising the outcomes of the implementation phase, underscoring the successful incorporation of AI to enhance user interaction and backend architecture designed for scalable data management. It reflects on the strategic use of React Native and various libraries that facilitated the creation of a dynamic and responsive user interface. The chapter also revisits the testing stages that verified the app's performance, highlighting the key issues identified and the steps taken to address them. The integration of AI not only enriched the app's functionality but also showcased the potential for future enhancements and expansions in serving a broader demographic.

Chapter 7

Discussion

and Conclusion

7.1 Chapter Overview

This chapter provides a comprehensive evaluation of the research findings, discusses the implications of the study, and concludes with insights on the potential impact and future directions for the Pawfect Diet app. It synthesises the results from previous chapters to assess the effectiveness of the app in meeting the project's objectives and addresses the research questions posed at the outset. Additionally, this chapter identifies the limitations encountered during the study and suggests areas for future research and development to enhance the app's capabilities and user experience.

7.2 Discussion

7.2.1 Effectiveness of AI-Generated Dietary Recommendations

The Pawfect Diet app successfully integrates AI technologies to offer Personalised dietary recommendations tailored to individual dogs. The AI-generated daily logs and the Vet Care chat feature demonstrate the potential of AI to provide accurate and breed-specific nutrition plans, addressing the first research question. Survey results from dog owners indicate a high level of satisfaction with the Personalised diet plans and calorie tracking features, highlighting the app's effectiveness in delivering precise and tailored nutritional advice. However, the mixed trust levels among users suggest a need for continuous improvement in AI accuracy and reliability to enhance user confidence.

7.2.2 Integration Challenges and Solutions

Integrating AI with user input for precise canine diet tracking posed several challenges, particularly in ensuring the accuracy and reliability of AI-generated recommendations. The iterative agile development approach, combined with extensive user feedback, helped address these challenges by refining the AI functionalities and enhancing the user interface. The hybrid approach of combining manual calculations with AI-generated suggestions mitigated some of the limitations of the AI model, ensuring more accurate and reliable health goal and calorie calculations. This approach effectively answered the second research question by demonstrating a practical solution to integrating AI in a user-friendly and accurate manner.

7.2.3 User Trust and Reliability Measures

The study reveals a generally positive perception of AI among dog owners, with a majority expressing trust in the AI-driven recommendations provided by the Pawfect Diet app. However, concerns about the accuracy and breed-specific customisation of AI recommendations were noted, particularly among veterinarians. To enhance trust and ensure the reliability of AI recommendations, the app incorporates features like detailed feedback on daily logs and dynamic profile updates based on user interactions. These measures address the third research question by providing transparency and reinforcing the app's credibility.

7.2.4 Design Principles and User Interface Features

The design and development of Pawfect Diet were guided by key design principles and user interface features aimed at creating an intuitive and engaging user experience. The app's user-friendly interface ensures a seamless interaction for users, effectively answering the fourth research question. Feedback from usability testing confirmed that the design elements, such as the intuitive

navigation and interactive Vet Care chat, significantly enhance user engagement and satisfaction, aligning with the app's goal of providing a user-centric solution for canine dietary management.

7.3 Limitations

Despite the successful development and positive reception of the Pawfect Diet app, several limitations were identified: the AI model initially faced challenges in accurately calculating health goals and calorie needs, underscoring the need for refinement and the integration of more advanced AI models; the app's primary focus on Jack Russell Terrier and German Shepherd breeds limits its applicability to other breeds, highlighting the necessity for future expansion to accommodate a broader range of dog breeds; and the reliance on manually imported food data indicates a need for integrating a comprehensive public database to enhance the app's food options and user convenience. These constraints were addressed with the aim of creating a demonstration-ready product.

7.4 Future Research and Development

To further enhance the Pawfect Diet app and address its limitations, several areas for future research and development are proposed:

- **Advanced AI Integration:** Future work should explore integrating more advanced AI models from newer platforms to improve the accuracy and reliability of health goal and calorie calculations. Additionally, the development of a specialised AI tailored specifically for canine nutrition management could be considered.
- **Expanded Breed Database:** It is planned to expand the app's breed recognition capabilities to include a wider range of breeds, thereby enhancing the app's applicability and value to a broader user base.
- **Comprehensive Food Database:** Integrating a public food database is essential to provide users with a more extensive selection of food options, thereby improving the app's functionality and user experience.
- **Enhanced User Feedback Mechanisms:** Developing more sophisticated feedback mechanisms to continuously gather and incorporate user feedback is crucial. This will ensure the app evolves in line with user needs and technological advancements.
- **Development of New Features:** It is planned to add features such as reminders, community-driven functionalities to transform the app into a social network, and the integration of real veterinarians for consultations. Additionally, adapting food logs based on reported sicknesses, implementing functionalities to save favourite foods and recipes, and integrating barcode scanning for commercial food products are all included in future development plans to significantly enhance user convenience and app usability.

7.6 Conclusion of Thesis

The development of the Pawfect Diet app signifies a transformative advancement in the application of Artificial Intelligence to enhance canine dietary management. This dissertation has meticulously documented the creation of an innovative AI-driven mobile application designed to offer Personalised, breed-specific dietary recommendations, tailored to meet the unique nutritional needs of individual dogs. By leveraging modern AI technologies, such as GPT-3.5 Turbo model, the app effectively bridges the gap between sophisticated technology and practical pet care solutions.

Pawfect Diet's design is firmly anchored in a user-centric approach, ensuring an intuitive and engaging experience for dog owners. Key features, such as AI-generated daily logs, interactive Vet Care chat, and comprehensive calorie tracking, underscore the app's commitment to enhancing user engagement and satisfaction. The positive feedback from usability testing highlights the app's effectiveness in delivering precise, tailored nutritional advice, thereby addressing the diverse needs of its users. These capabilities align with current research emphasising the importance of Personalised nutrition in improving pet health outcomes, as noted by Hoummady et al. (2022) and Kazimierska & Biel (2020).

Despite the successful implementation and favourable reception, the study acknowledges certain limitations, including the initial focus on a limited range of breeds and the reliance on a manually imported food database. These constraints underscore the need for future enhancements. Moreover, it is considered to expand the application capabilities with the development of many extra features.

The potential impact of Pawfect Diet extends beyond technological innovation, aiming to significantly improve canine health and well-being. The app's ability to provide scientifically grounded, Personalised dietary recommendations addresses a critical need highlighted by studies such as Wainwright et al. (2022), which emphasise the gap in reliable, accessible dietary guidance for pet owners. By empowering dog owners with precise nutritional insights, Pawfect Diet contributes to more informed and effective pet care practices, ultimately enhancing the quality of life for dogs.

In conclusion, Pawfect Diet stands as a pioneering example of AI's potential to transform pet care, offering a scalable and impactful solution for modern canine dietary management. The app not only addresses a significant gap in the market but also sets a benchmark for integrating AI technologies in practical applications, promoting healthier, more balanced diets for dogs. This project lays a robust foundation for future advancements in AI applications in pet care, fostering greater acceptance and trust in AI-driven solutions among consumers and professionals alike. Continued innovation and user-centric enhancements will be essential in establishing Pawfect Diet as a leading tool in the field of AI-driven pet care, ultimately contributing to improved health and well-being for dogs and greater satisfaction for their owners.

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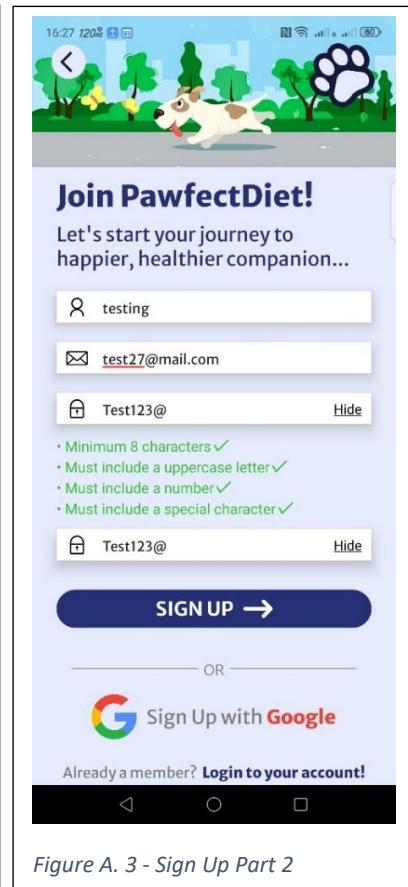
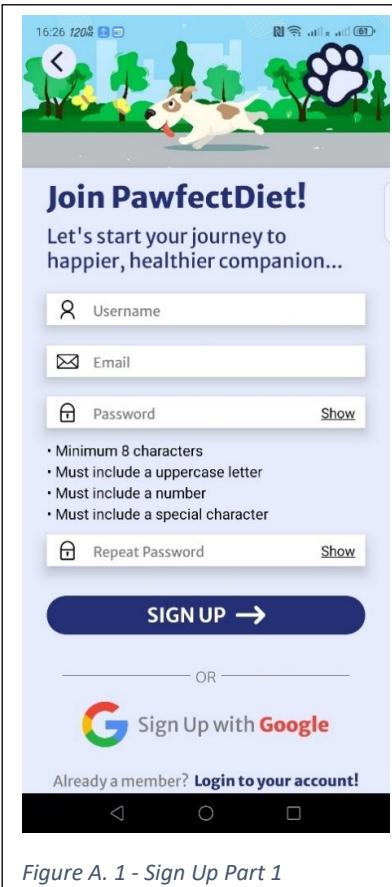
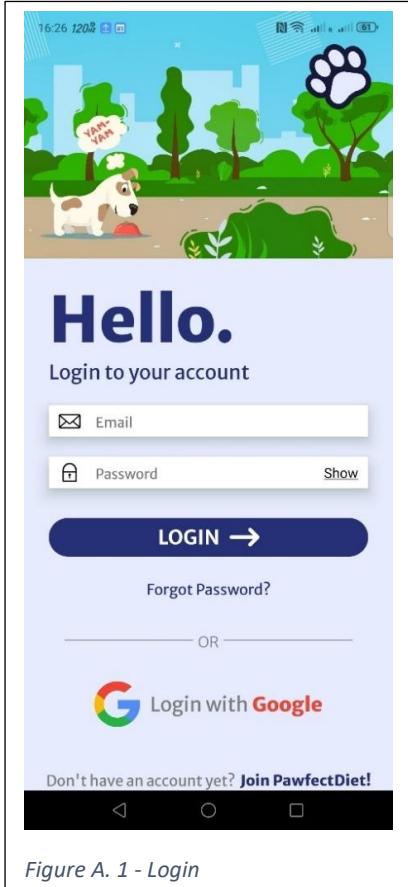
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Appendix A

App Screenshots

This section includes screenshots of the application taken from my phone during testing. Additionally, a video presentation of the app is available on YouTube, accessible through the following link:



Basic Details
Start by sharing the basic about your furry friend.

Dog's Name:

Why do we need these info?
We know it's a lot, but the more information you give us, the more the AI will be accurate!

OK

When was your dog born?

What is your dog gender?
 Male ♂ Female ♀

Next →

Figure A. 4 - Create Dog Profile Part 1

Basic Details
Start by sharing the basic about your furry friend.

Dog's Name:

Breed:

Not sure? Use the [Breed Recognition](#)

When was your dog born?

What is your dog gender?
 Male ♂ Female ♀

Next →

Figure A. 5 - Create Dog Profile Part 2

Health & Lifestyle
Tell us about the general health and daily activities of Rocky

Is Rocky a working/sporting dog?
 Yes No

Type of working/sporting dog:

Other Activities:

Activity Level:

Weight: Kg Lbs

Figure A. 6 - Create Dog Profile Part 3

Is Rocky currently taking any regular medication?

Are there any Major Health Changes that we should know about?
 Yes No

Please specify:

Is Rocky allergic to something?
 Yes No

Enter allergy:

Is Rocky Neutered?
 Yes No

Next →

Figure A. 7 - Create Dog Profile Part 4

Weight:

Flea and Tick Preventatives
Heartworm Preventatives
Anti-inflammatory Medications
Allergy Medications
Anxiety Medications
Thyroid Medications
Worm Treatment
Not Under Regular Medication

Is Rocky Neutered?
 Yes No

Next →

Figure A. 8 - Create Dog Profile Part 5

Is Rocky allergic to something?
 Yes No

Is Rocky Spayed?
 Yes No

Is Rocky Pregnant?
 Yes No

Duration of Pregnancy: Months > 0 Weeks > 0

Is Rocky Breastfeeding?
 Yes No

Next →

Figure A. 9 - Create Dog Profile Part 6

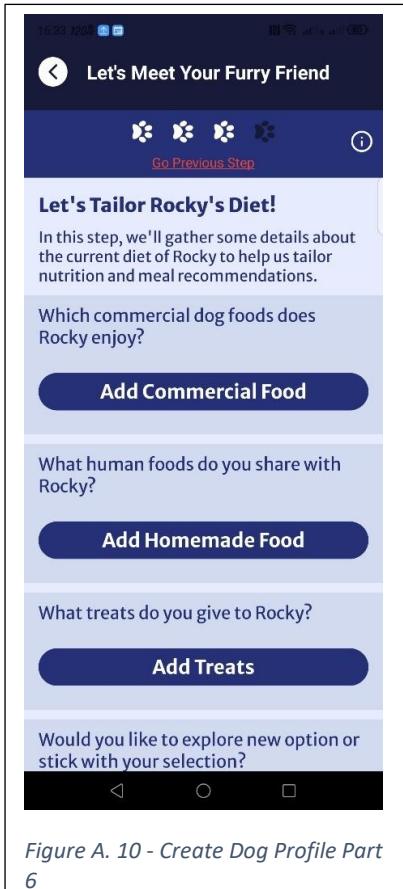


Figure A. 10 - Create Dog Profile Part 6

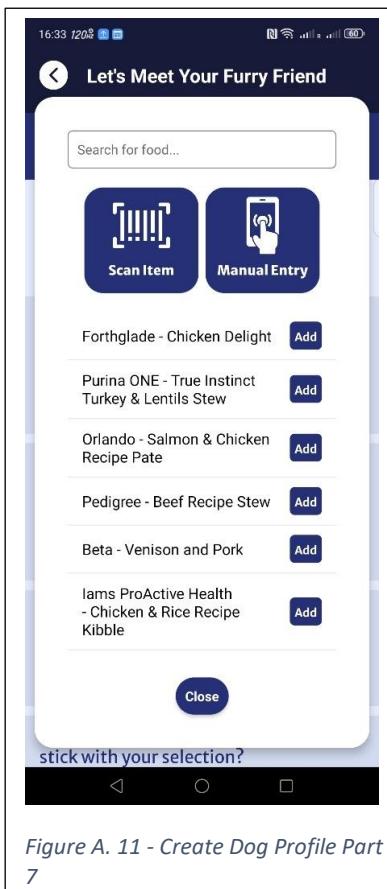


Figure A. 11 - Create Dog Profile Part 7

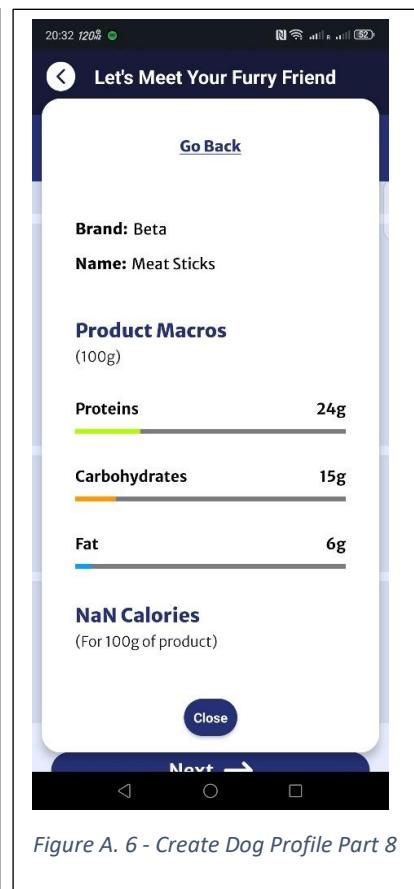


Figure A. 6 - Create Dog Profile Part 8

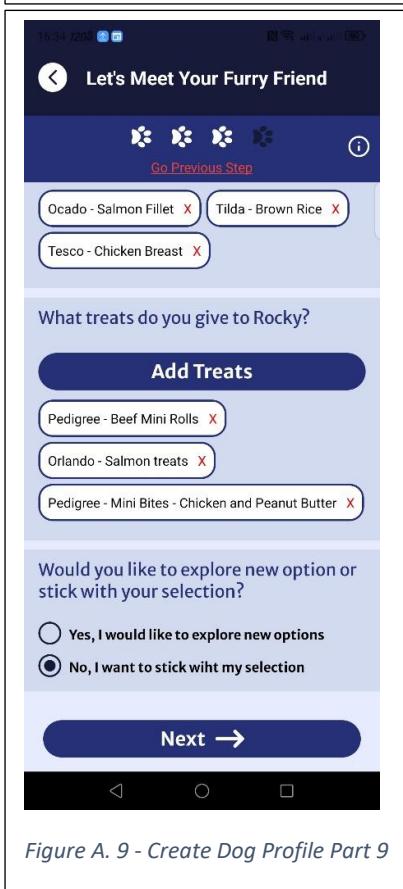


Figure A. 9 - Create Dog Profile Part 9

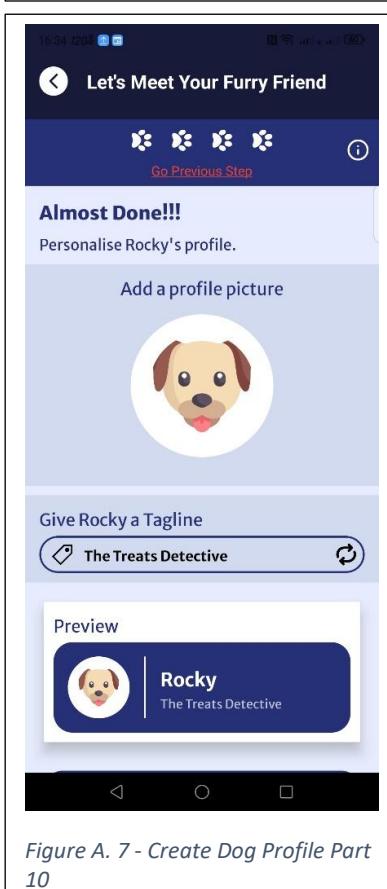


Figure A. 7 - Create Dog Profile Part 10

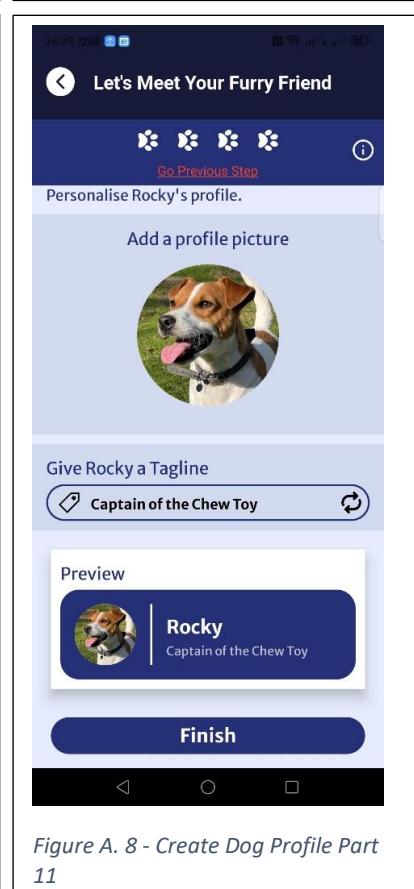


Figure A. 8 - Create Dog Profile Part 11



Figure A. 11 - Dashboard Part 1

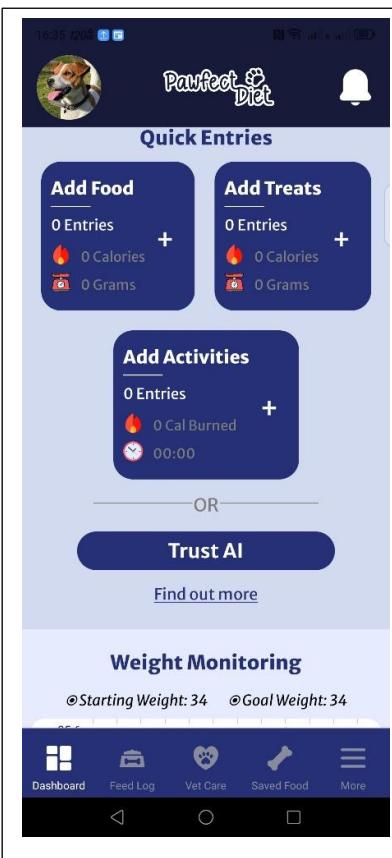
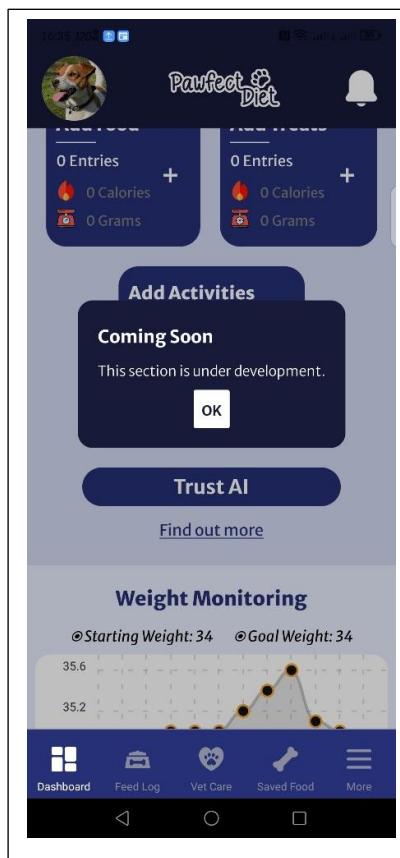


Figure A. 17 - Dashboard Part 2



Fiaure A. 10 - Dashboard Part 3



Figure A. 19 - Dashboard Part 4



Fiaure A. 20 - Dashboard Part 5

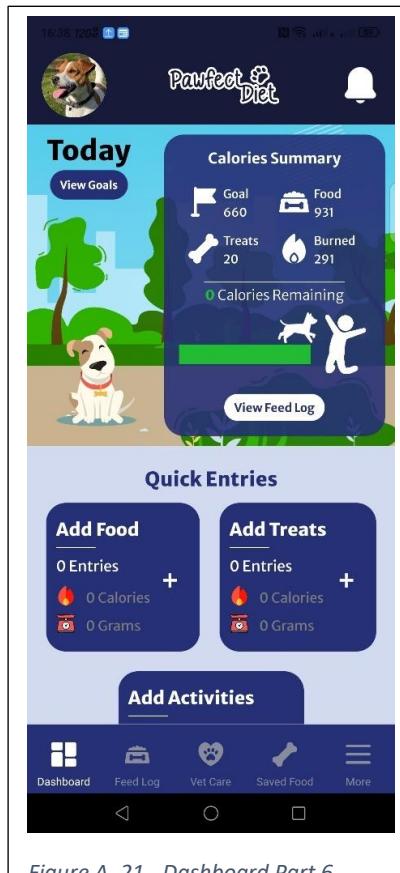


Figure A. 21 - Dashboard Part 6



Figure A. 12 - Dashboard Part 7

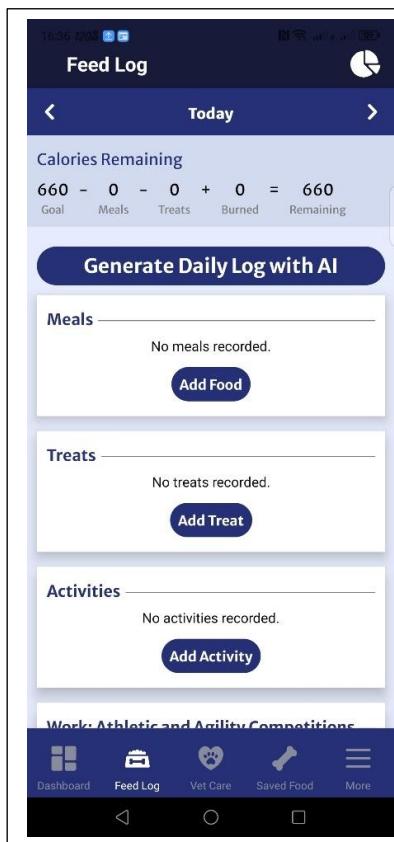


Figure A. 23 - Feed Log Part 1

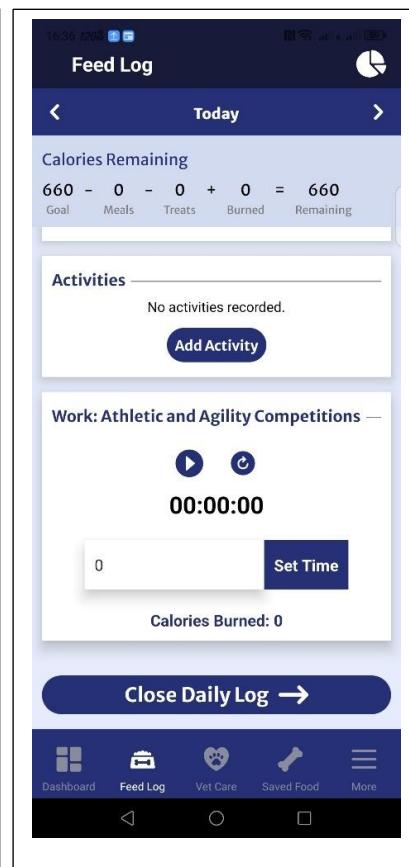


Figure A. 24 - Feed Log Part 2

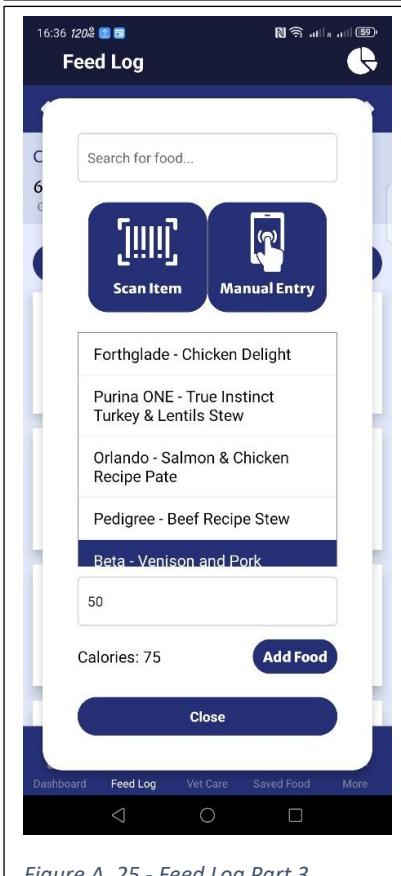


Figure A. 25 - Feed Log Part 3

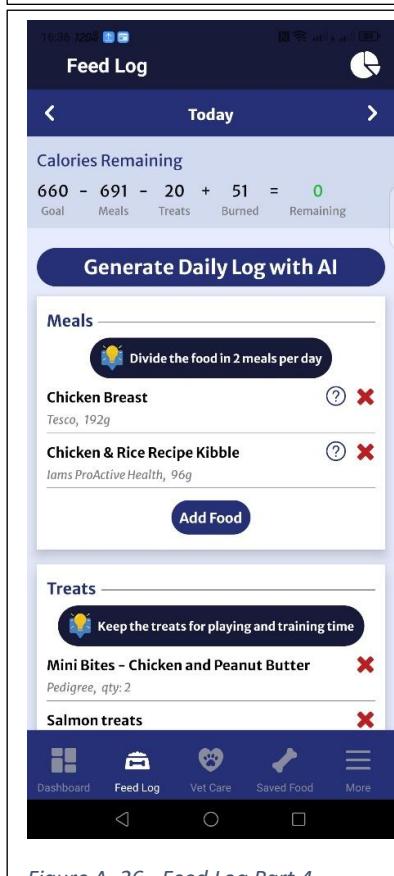


Figure A. 26 - Feed Log Part 4

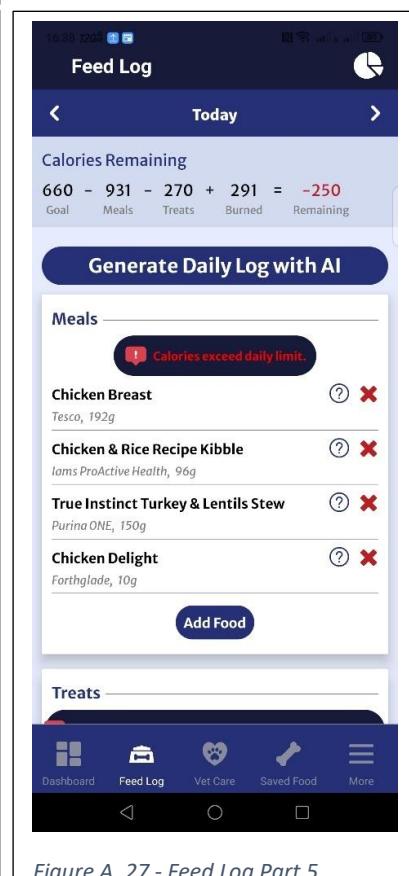


Figure A. 27 - Feed Log Part 5

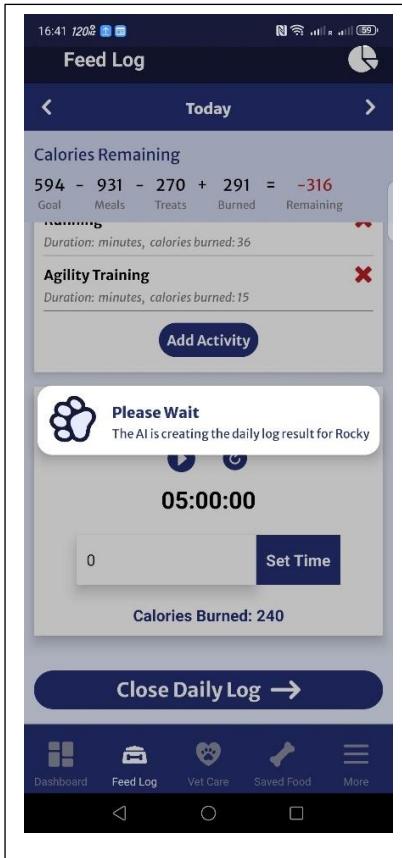


Figure A. 28 - Feed Log Part 6



Figure A. 29 - Feed Log Part 7

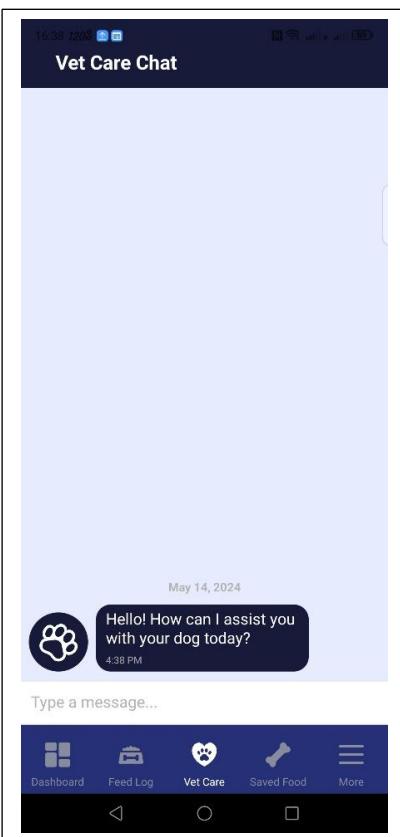


Figure A. 30 – Vet Care Part 1



Figure A. 31 - Vet Care Part 2

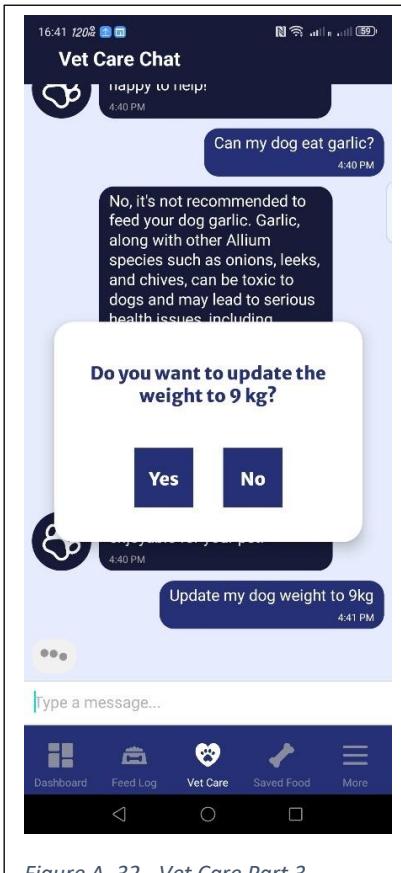


Figure A. 32 - Vet Care Part 3

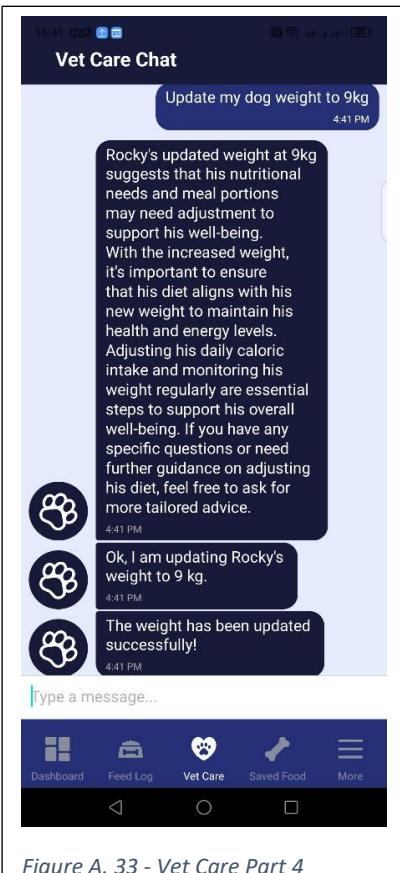


Figure A. 33 - Vet Care Part 4

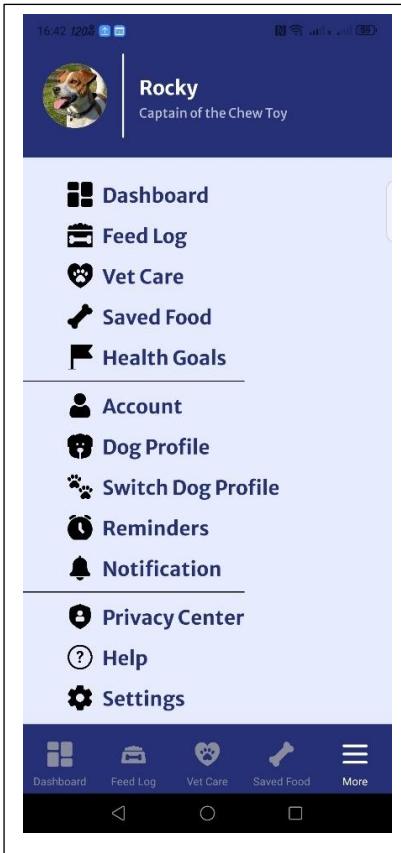


Figure A. 34 - Menu Part 1

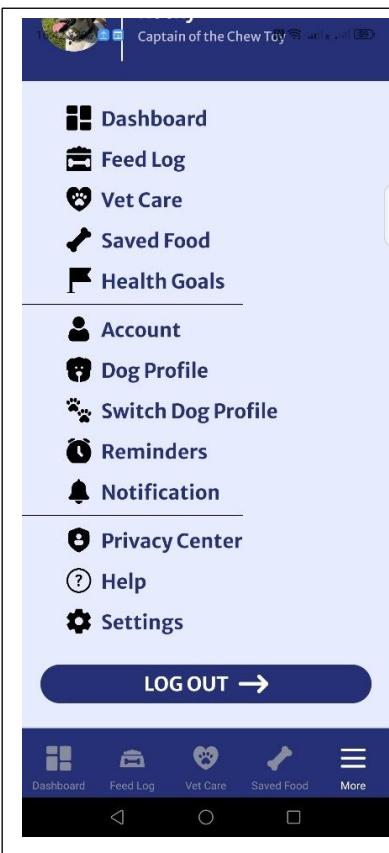


Figure A. 35 - Menu Part 2



Figure A. 36 - Health Goals Part 1

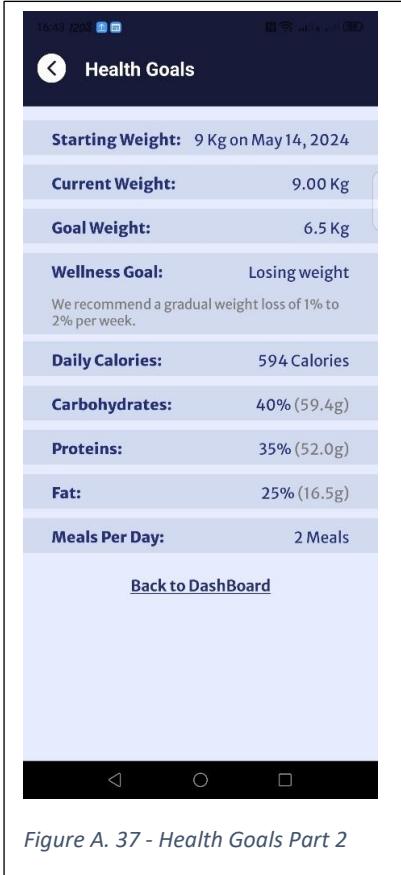


Figure A. 37 - Health Goals Part 2

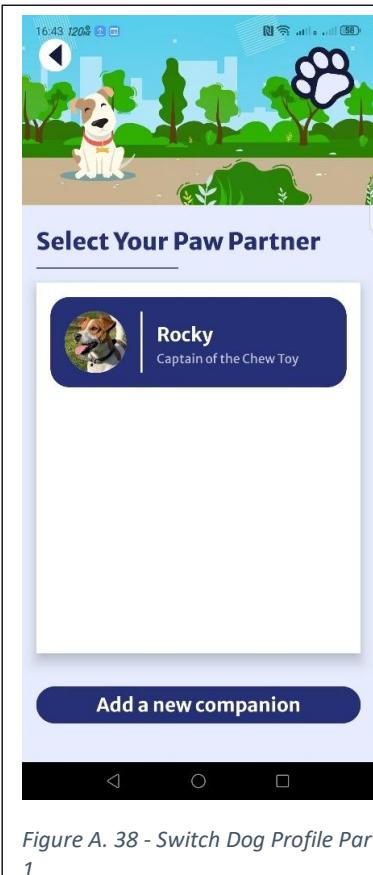


Figure A. 38 - Switch Dog Profile Part 1

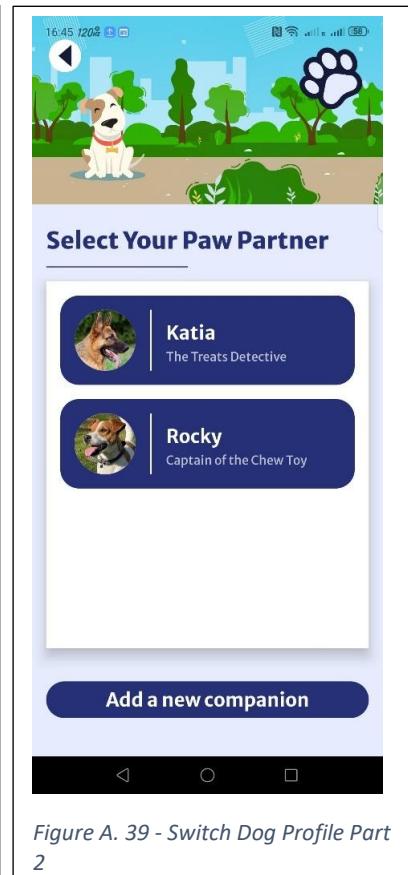


Figure A. 39 - Switch Dog Profile Part 2

Code

The source code for this application is available on GitHub. For detailed usage instructions, please visit the repository at the following link:

<https://github.com/Emanuele-Sgroi/PawfectDiet>

Appendix B

Survey For Dog Owners

The screenshot shows the opening page of a survey titled "Canine Companion Nutrition Helper: Share Your Experience for a Tailored Diet App". The page is blue-themed with white text. It explains that the survey is part of a research study aimed at developing a mobile application dedicated to improving canine health through personalized diet management. The study seeks to understand the diverse experiences of dog owners regarding their pets' dietary habits and preferences. Participation is voluntary, and all information provided will remain confidential and will be used solely for the purpose of this research.

Below the main text, there is a section for a dropdown menu:

* Required

1. What is your dog's breed? *

If your dog's breed isn't listed or you're unsure of their breed, please select "Other" or the breed that most closely resembles your dog.

Select your answer

Figure B. 1 - Survey for Dog Owners Part 1

The screenshot shows the second part of the survey. Question 2 asks "Can you estimate the age of your dog? *". The options are: Less than 1 year, 1 - 3 years, 4 - 7 years, and 8 years and above. Question 3 asks "How do you currently manage your dog's diet? *". The options are: I follow the vet's recommendations, I create a diet based on online research, I use a mobile app to track the diet, I follow my instincts/previous experience, and Other. Question 4 asks "How confident are you in understanding your dog's nutritional needs? *". The scale ranges from 1 (Very unconfident) to 5 (Very confident).

Figure B. 2 - Survey for Dog Owners Part 2

5. Have you ever used any of the applications or AI services listed below for managing your dog's diet? *

Please select all that apply or specify any other application you have used that is not listed.

- NutriPetDog
- PAWSM
- Daisy
- My Fat Dog Diet
- ChatGPT or/and other AI services
- I have used an application for this purpose but cannot recall its name.
- I have never used an application for managing my dog's diet.
- Other

6. What features would you find most helpful in a dog diet and nutrition management app? *

- Personalized diet plans
- Calorie tracking
- Nutritional analysis
- Barcode scanning for food items
- Integration with vet recommendations
- Other

Figure B. 3 - Survey for Dog Owners Part 3

7. How difficult was it for you to figure out how to feed your dog when you first adopted it? *

1	2	3	4	5
---	---	---	---	---

Very easy Very difficult

8. Would you trust an AI-driven app to provide dietary recommendations for your dog? *

Yes
 No
 Maybe

9. What concerns might prevent you from using an AI-powered diet app for your dog? *

Enter your answer

10. How likely are you to use a diet and nutrition management app if it is tailored to your dog's breed and activity level? *

1	2	3	4	5
---	---	---	---	---

Very unlikely Very likely

Figure B. 4 - Survey for Dog Owners Part 4

11. Would you be willing to manually input your dog's meals into an app to track their diet? *

Yes
 No
 Maybe

12. What is the most challenging aspect of managing your dog's diet? *

Example: Calories intake

Enter your answer

13. Is your dog a working dog or involved in high-intensity activities like agility training, herding, or service work? *

A working dog is a dog that perform professional and/or sporting activities regularly, such as police dogs, running competitions etc...

Yes
 No

Figure B. 5 - Survey for Dog Owners Part 5

14. How often do you review or change your dog's diet plan? *

Regularly, with every vet visit.

Occasionally, when I notice health/weight changes.

Rarely or never.

15. Do you monitor your dog's weight and adjust their diet accordingly? *

Yes

I monitor the weight but I don't adjust the diet

No

16. If your dog performs more intense activity for one or two days, do you adjust their calorie intake to match their increased energy expenditure? *

Yes

No

Not sure

Figure B. 6 - Survey for Dog Owners Part 6

17. When using a new app, how many steps would you be willing to take to complete a task like entering a meal? *

Please select the maximum number of steps that you find acceptable

Only 1 step

Up to 2 steps

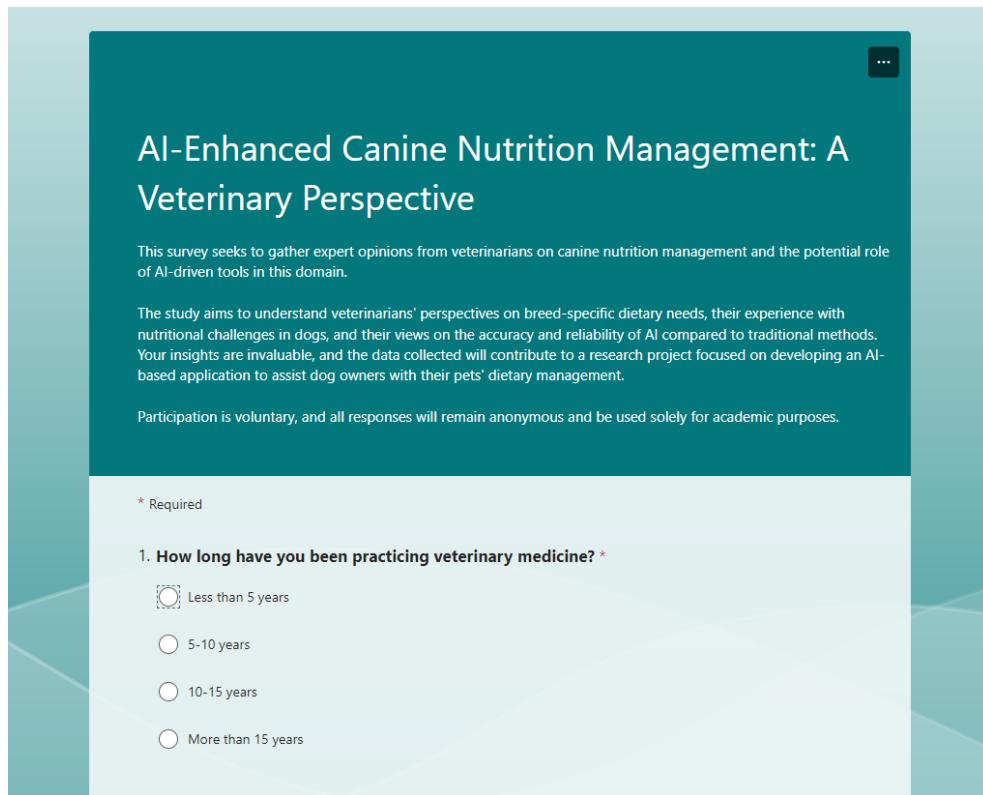
Up to 3 steps

4 steps or more

Submit

Figure B. 7 - Survey for Dog Owners Part 7

Survey For Veterinarians

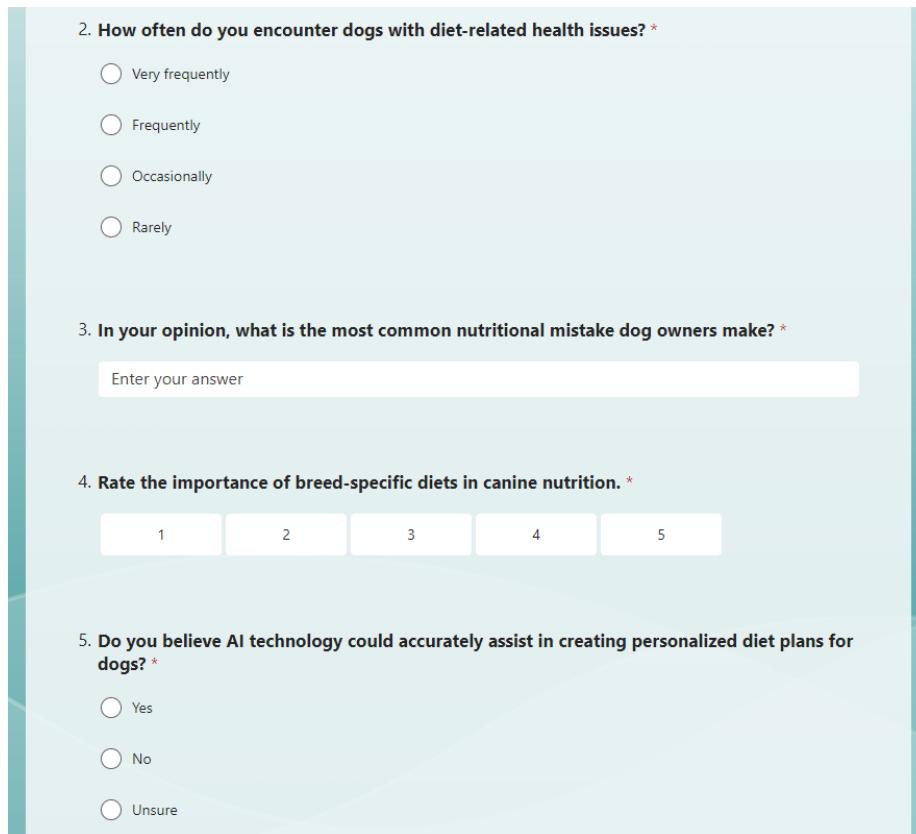


The screenshot shows the first page of a survey titled "AI-Enhanced Canine Nutrition Management: A Veterinary Perspective". The title is centered at the top in a large white font. Below it is a brief introduction: "This survey seeks to gather expert opinions from veterinarians on canine nutrition management and the potential role of AI-driven tools in this domain." A detailed description follows: "The study aims to understand veterinarians' perspectives on breed-specific dietary needs, their experience with nutritional challenges in dogs, and their views on the accuracy and reliability of AI compared to traditional methods. Your insights are invaluable, and the data collected will contribute to a research project focused on developing an AI-based application to assist dog owners with their pets' dietary management." A note about participation: "Participation is voluntary, and all responses will remain anonymous and be used solely for academic purposes." At the bottom left, there is a small note: "* Required".

1. How long have you been practicing veterinary medicine? *

Less than 5 years
 5-10 years
 10-15 years
 More than 15 years

Figure B. 8 - Survey for Veterinarians Part 1



The screenshot shows the second page of the survey. Question 2 asks: "2. How often do you encounter dogs with diet-related health issues? *". The options are: "Very frequently", "Frequently", "Occasionally", and "Rarely". Question 3 asks: "3. In your opinion, what is the most common nutritional mistake dog owners make? *". There is a text input field with placeholder text "Enter your answer". Question 4 asks: "4. Rate the importance of breed-specific diets in canine nutrition. *". There is a horizontal scale with five numbered boxes: 1, 2, 3, 4, and 5. Question 5 asks: "5. Do you believe AI technology could accurately assist in creating personalized diet plans for dogs? *". The options are: "Yes", "No", and "Unsure".

2. How often do you encounter dogs with diet-related health issues? *

Very frequently
 Frequently
 Occasionally
 Rarely

3. In your opinion, what is the most common nutritional mistake dog owners make? *

Enter your answer

4. Rate the importance of breed-specific diets in canine nutrition. *

1 2 3 4 5

5. Do you believe AI technology could accurately assist in creating personalized diet plans for dogs? *

Yes
 No
 Unsure

Figure B. 9 - Survey for Veterinarians Part 2

6. What are the key dietary considerations you take into account when advising on a dog's nutrition plan? *

Breed
 Age
 Weight
 Activity level
 Other

7. Do you believe an AI could accurately assist in creating personalized diet plans for dogs, compared to a veterinarian's expertise? *

Definitely yes
 Possibly yes
 Neutral
 Possibly no
 Definitely no

Figure B. 10 - Survey for Veterinarians Part 3

8. How likely are you to recommend an AI-driven nutrition app to dog owners if it's proven accurate and reliable? *

Very likely
 Somewhat likely
 Neither likely nor unlikely
 Somewhat unlikely
 Very unlikely

9. What features would you consider essential for an AI-driven canine diet management app? *

Personalized diet plans
 Calorie tracking
 Nutritional analysis
 Barcode scanning for food items
 Integration with vet recommendations
 Other

Figure B. 11 - Survey for Veterinarians Part 4

10. Please provide any additional comments or suggestions you have about integrating AI into canine dietary management.*

Enter your answer

11. How do you adjust dietary recommendations for working dogs compared to companion dogs? *

Enter your answer

12. If an AI system was as accurate as a veterinarian in providing dietary advice, would that impact your practice? *

Yes

No

Maybe

Submit

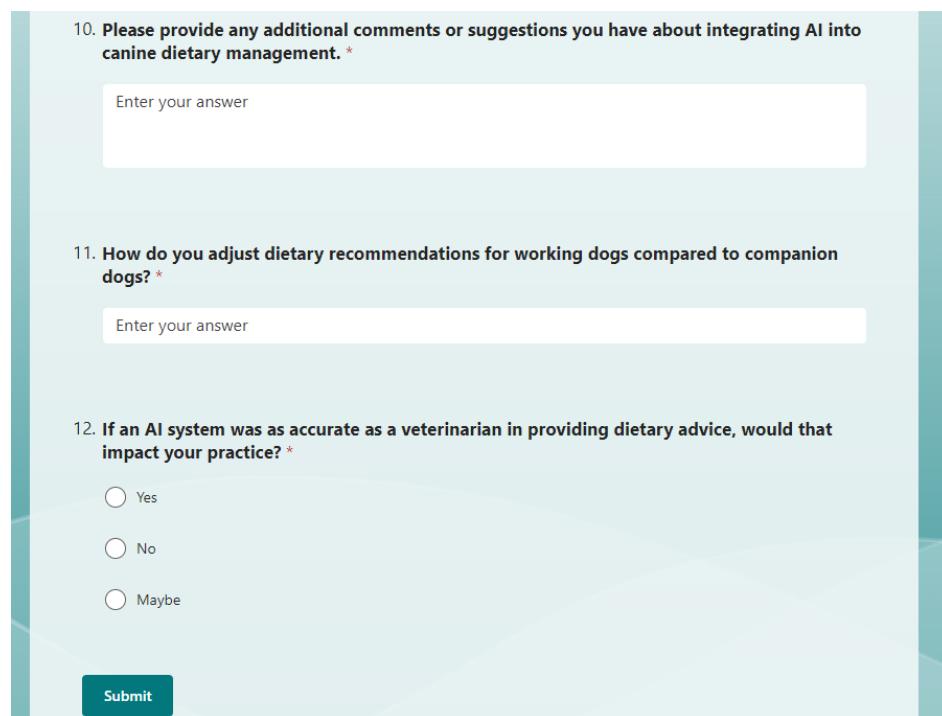


Figure B. 12 - Survey for Veterinarians Part 5

Survey Post-Usability Test

Pawfect Diet Usability and AI Trust Survey

Thank you for participating in the Pawfect Diet Usability and AI Trust Survey, a crucial part of my dissertation research. This survey aims to gather insights into your experience with the Pawfect Diet app, focusing on usability, ease of navigation, and trust in its AI features.

Participation is voluntary, and all information provided will remain confidential and will be used solely for the purpose of this research. Your input is greatly appreciated and will contribute significantly to the well-being of dogs and the convenience of their caregivers. Your feedback is invaluable in helping us improve the app and enhance the user experience. Thank you for your time and contribution!

* Required

1. Age Group *

Under 18

18-24

25-34

35-44

45-54

55-64

65 and older

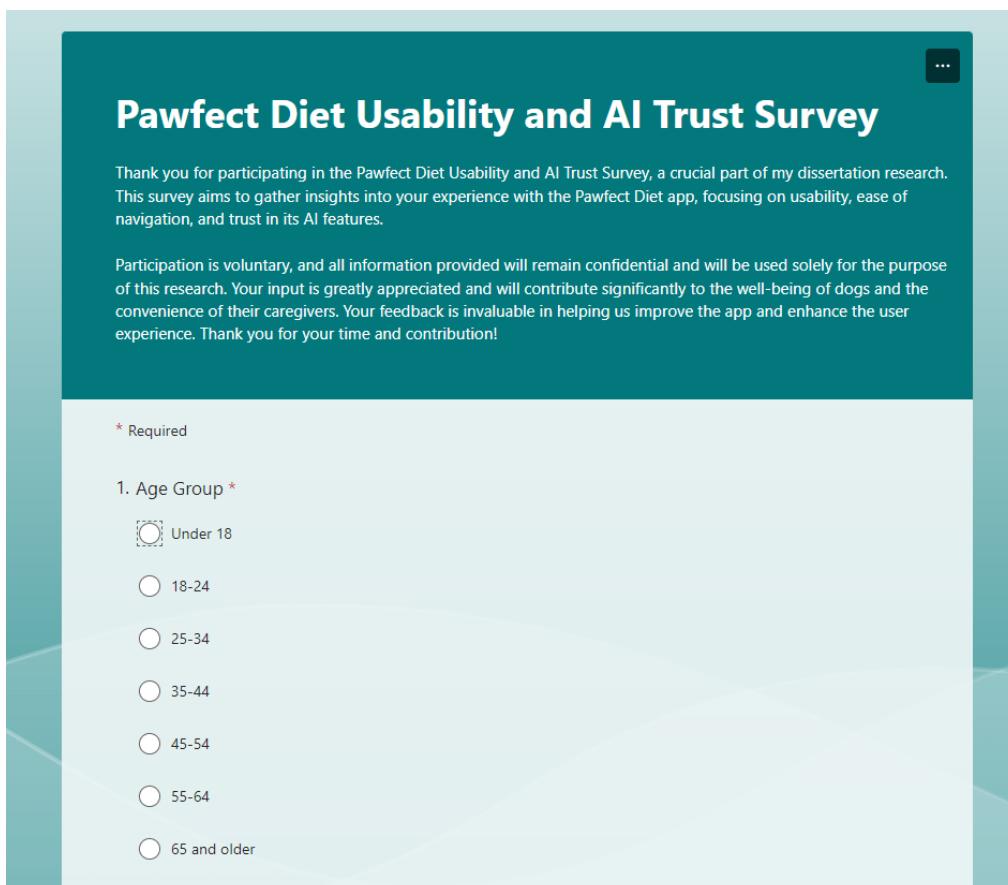


Figure B. 13 - Survey Post-Usability Test Part 1

2. Have you ever used a pet diet app before? *

Yes

No

3. Have you ever used AI services such as ChatGPT before? *

Yes

No

4. How easy was it to navigate through the app? *

Very Easy

Easy

Neutral

Difficult

Very Difficult

Figure B. 14 - Survey Post-Usability Test Part 2

5. Did you encounter any difficulties while creating a dog profile? *

Yes

No

6. If yes, please describe

Enter your answer

7. How satisfied are you with the calorie tracker feature (Dashboard and Feed Log)? *

Very satisfied

Somewhat satisfied

Neither satisfied nor dissatisfied

Somewhat dissatisfied

Very dissatisfied

Figure B. 15 - Survey Post-Usability Test Part 3

8. How satisfied are you with the Feed Log feature? *

- Very satisfied
- Somewhat satisfied
- Neither satisfied nor dissatisfied
- Somewhat dissatisfied
- Very dissatisfied

9. How useful did you find the AI-generated daily log? *

- Extremely useful
- Somewhat useful
- Neutral
- Somewhat not useful
- Extremely not useful

Figure B. 16 - Survey Post-Usability Test Part 4

10. How would you rate your experience with the Vet Care chat feature? *

- Excellent
- Good
- Average
- Needs improvement
- Poor

11. Do you trust the AI's recommendations? *

- Yes
- No
- Maybe

Figure B. 17 - Survey Post-Usability Test Part 5

12. How useful did you find the detection feature for updates within Vet Care? *

- Extremely useful
- Somewhat useful
- Neutral
- Somewhat not useful
- Extremely not useful

13. What did you like the most about the app? *

Enter your answer

14. What improvements would you suggest for the app? *

Enter your answer

15. From 1 to 5, how much do you like the overall idea behind the project? *

- 1
- 2
- 3
- 4
- 5

Figure B. 18 - Survey Post-Usability Test Part 6

16. Would you use this app regularly for managing your dog's diet? *

- Definitely
- Probably
- Not Sure
- Probably Not
- Definitely Not

Submit

Figure B. 19 - Survey Post-Usability Test Part 7