Faculty of Computer Science and Information Technology

PawDetect: Breed Identifier For Dogs

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ABSTRACT

Professional breeders and veterinarians often face challenges determining a dog's breed based only on appearance. Breed information is becoming increasingly essential to pet owners, particularly for providing proper breed-specific care. However, lacking awareness and understanding of local dog breeds often leads to care and adoption challenges. Thus, this project developed a mobile application designed to help identify dog breeds, especially local ones, while providing users with essential breed-specific information. The application utilizes image recognition technology to identify breeds. Users can take a real-time photo or upload an existing photo from the gallery. It also provides users with general and specific breed information for better care for their furry. Users can create individual profiles for each dog to ease the management of multiple dogs. The accuracy of the breed identification feature were evaluated using n=50 dog images obtained from the internet and the author's personal images.

ABSTRAK

Penternak profesional dan doktor haiwan sering menghadapi cabaran dalam menentukan baka anjing berdasarkan penampilan. Maklumat tentang baka semakin penting bagi pemilik anjing, terutamanya untuk memberi penjagaan yang sesuai mengikut keperluan spesifik setiap baka. Walau bagaimanapun, kekurangan kesedaran dan pemahaman mengenai baka anjing tempatan sering membawa cabaran dalam penjagaan dan pengambilan anjing. Oleh itu, projek ini mencadangkan aplikasi mudah alih yang direka untuk membantu mengenal pasti baka anjing, terutamanya baka tempatan, dengan maklumat penting tentang baka tersebut. Aplikasi ini menggunakan teknologi pengenalan imej untuk mengenal pasti baka. Pengguna boleh mengmbil gambar secara langsung atau memuat naik gambar yang sedia ada dari galleri. Aplikasi ini juga memberikan maklumat umum dan spesifik mengenal baka untuk penjagaan yang lebih baik bagi anjing peliharaan mereka. Pengguna boleh mencipta profil individu untuk setiap anjing peliharaan bagi memudahkan pengurusan anjing yang lebih dari satu. Ketepatan pengenalan baka dinilai menggunakan n=50 gambar anjing yang diperoleh dari internet dan gambar peribadi pengarang.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Nowadays, more and more people are falling in love with pets since their living standards have improved, while pet dogs are the most popular choice. However, many dog breeds have similar appearances. These dogs also differ in various ways, including their tendencies to love and dislike things (Varshney et al., 2021). Furthermore, certain breeds could have health issues like bloat. As a result, breed information is becoming increasingly essential to owners. The breed identification apps can assist owners in knowing the nutritional preferences, care routines, and personality traits of their pets. Besides, different dog breeds can bring various problems (Wang et al., 2020). For example, larger dogs may be more aggressive and can cause health problems like rabies. If there is an app that can help identify dangerous dog breeds, it would benefit both pet owners and government agencies.

People often question dog breeds, incredibly mixed breeds. They usually start by looking at and comparing the dogs they feed or see with the pictures available online. This can be time-consuming and involve research, and the conclusions may not be accurate. Physical appearance can be misleading due to how dogs inherit traits. Some apps can be used to detect a dog's breed based on a photo, for instance, Dog Breed Identification (Dog Breed Identification – Apps on Google Play, 2021), Dog Scanner: Breed Recognition (Dog Scanner: Breed Recognition – Apps on Google Play, 2017), and AI based Dog Breed Identifier (AI Based Dog Breed Identifier – Apps on Google Play, 2022). This option is quick but not much more accurate than the previous one since figuring out breed based on looks alone can be tricky. Besides, the current dog breed identification apps are easy to detect wrongly on the local and Asian dog breeds since they focus more on the western breeds. Another way to identify the dog breed is to do a DNA test (Varshney et al., 2021). This is the most accurate method since the test analyzes the dog's genetic samples and compares them with a database of known breeds. This can help trace the dog's ancestry back three generations, even if it is a mixed breed. Although DNA testing is valuable to identify dog breeds, it still has some limitations. The testing can be expensive, especially from more comprehensive tests that include health screening.

Deep learning is a part of Artificial Intelligence (AI) and has strong learning capabilities (Wang et al., 2020). Object detection is a computer vision technique for locating and classifying objects in digital images and videos. It is an essential technology in deep learning. Object detection for local dog breeds is an approach to quickly detect and classify the dog's facial features and unique characteristics (Wang et al., 2020).

This project proposes an image-processing application to help dog owners and those who want to have dogs quickly identify a dog's breed. The application provides in-depth information on each breed, covering personality traits, health issues, lifespan, and others. It will be implemented in the English language.

1.2 Problem Statement

According to Dabrowski et al. (2021), professionals like breeders and veterinarians also have difficulties determining a dog's breed from sight. This can lead to pet owners mislabelling their dogs. Besides, many dogs look similar but are different in breed. These dogs also differ in their habits and characteristics (Varshney et al., 2021). Therefore, it is crucial to identify the breeds accurately and provide the proper care. Our initial experiments with the two available applications, Dog Breed Identification and Dog Identifier showed they had problems correctly identifying breeds. Both apps frequently misidentified Japanese Chin throughout testing. This indicates that the coverage of local dog breeds in their databases could be limited (Tiong, personal communication, October 13, 2024). The inability of these applications to reliably identify local breeds poses a significant challenge for pet owners who want to understand and care for their pets accurately. This project aims to offer a tailored solution that can accurately identify the local dog breeds and provide the correct breed knowledge to the users.

1.3 Scope

This application will be available on the Android Platform. Its target audience is dog owners and those who want to become dog owners. The primary language of this application will be the English language. The application will include image scanning and processing and provide the text and image details of the local dog breeds.

1.4 Research Questions and Objectives

The research questions of this project are:

1. How to automate the breed identification task?
2. Can we identify breeds based on visual information extracted from still images?

The objectives of this project include the following:

1. To build an Android app that can be used to identify local dog breeds
2. To implement the image-based classifier function into the app

1.5 Motivations

This project's motivation is to provide a platform for dog owners to learn and understand how to care for their companions. It also aims to help people to become more aware of the local dog breed.

1.6 Methodology

We will use Android Studio to develop the local dog breed identification app and follow the Software Development Life Cycle (SDLC) Model, as shown in Figure 1.1. This model includes six phases: Requirements Analysis, Design, Coding and Development, Testing, Deployment, and Review. Unlike the rigid traditional approach, which relies on a linear sequence of phases, Agile SDLC integrates planning, development, and testing in a cyclic process. Since it emphasizes flexibility, it allows the team to change its approach quickly and effectively to ensure that the final product remains relevant. Through continuous improvement and testing, development teams can identify and solve issues early. The ongoing evaluation can help minimize the risk of software development.

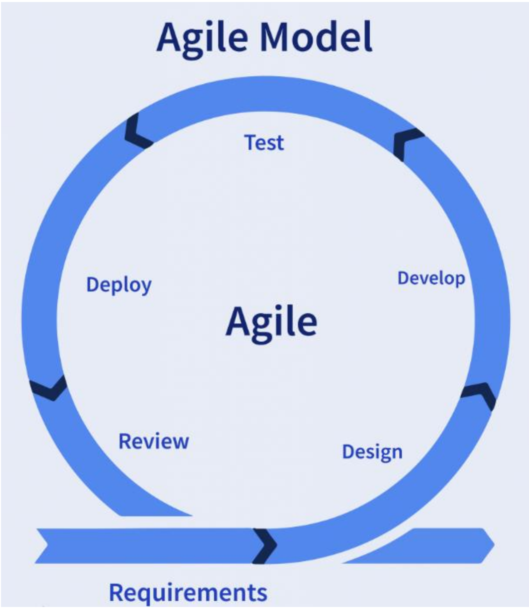


Figure 1.1: Agile SDLC (Agile Model Explained - SDLC, 2022)

The project's scope and objectives are defined in the first phase, Requirements Analysis. Then, all the needed information is gathered and analyzed. The information gathered defines the application's features and user requirements. The second phase is Design. This includes the process of designing the identification app's wireframes. The Unified Modelling Language (UML), such as Use Case Diagram, Class Diagram, and Sequence Diagram, is used to design the application. Besides, the app's overall architecture and the interactions between the database and the user interface are also planned in this phase. Next is the Coding and Development Phase. The app's core functionalities are developed in Android Studio during this phase. After the development phase, the testing phase commences. To ensure the application's functionality and friendly user experience, usability testing will be conducted with the targeted user, the dog owner, or someone who wants to be a dog owner. In the testing phase, the issues found during testing will be fixed. Then, the complete product will undergo the deployment phase for user testing again. The last phase is Review. All the users' feedback is collected to determine what must be improved.

Teachable Machine by Google is a user-friendly web-based tool that allows anyone to create machine learning models without programming (Teachable Machine, n.d.). It is designed to simplify the training model by using the camera to teach it to recognize specific images. Teachable Machine was chosen because it has a straightforward interface that guides the user through the training process. Besides, the Teachable Machine allows users to quickly upload images, train the model, and export it into their project, making it efficient for prototyping. First, to train the model, choose the input type, images, sounds, or poses. Once the image project is selected, users can use a webcam or upload pictures to capture examples of categories they want the model to recognize. Then, name the class of each category. The data is processed, and the model is trained automatically. The user can test the model to adjust and improve the performance. Once the model is suitable for use, it can be exported in the format that suits the project.

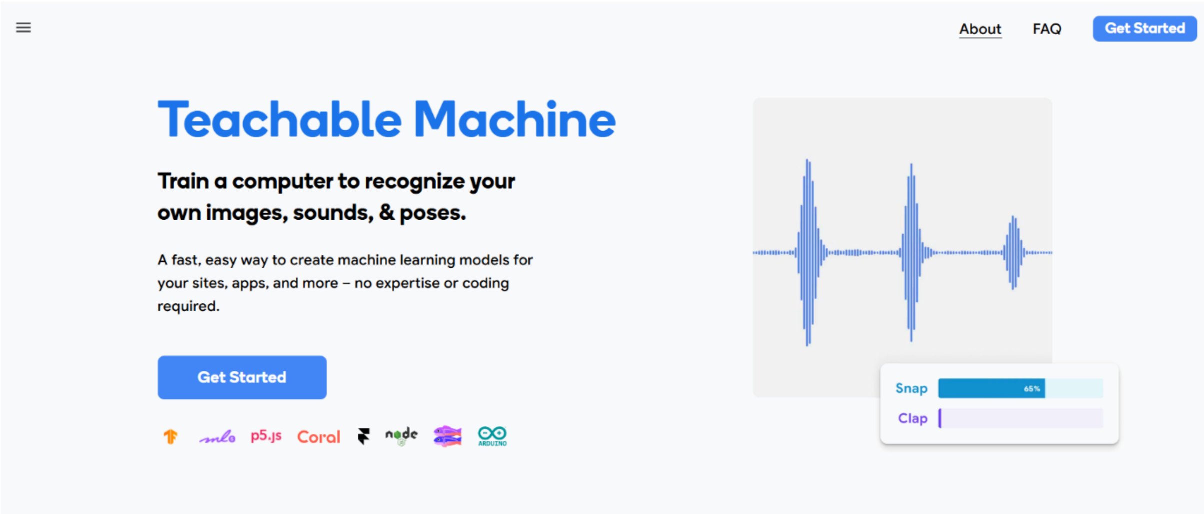


Figure 1.2: Teachable Machine - Starting screen

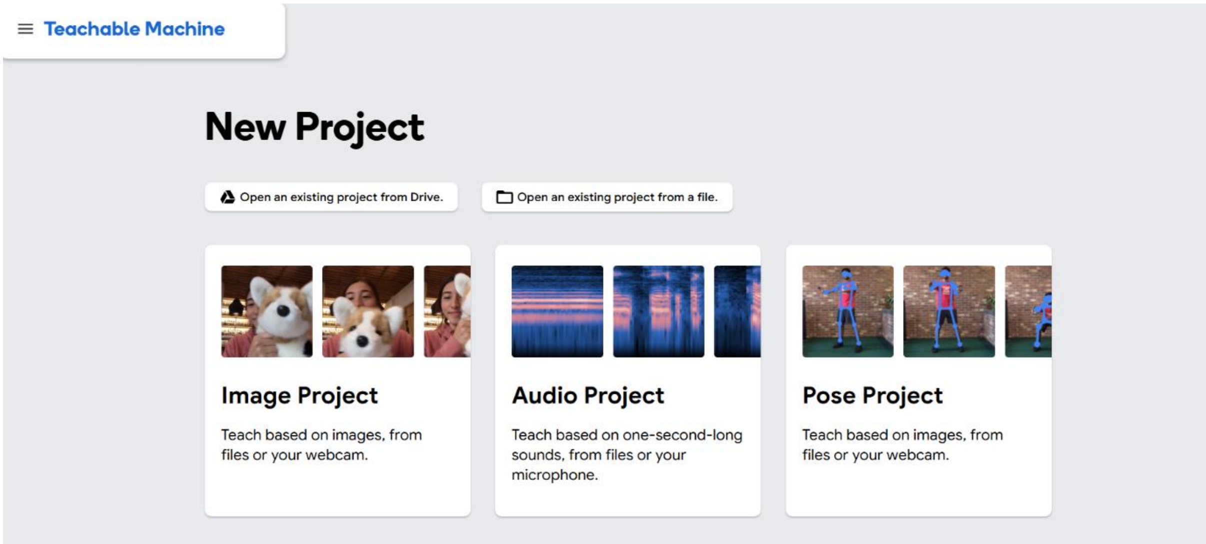


Figure 1.3: Teachable Machine – Choose project type

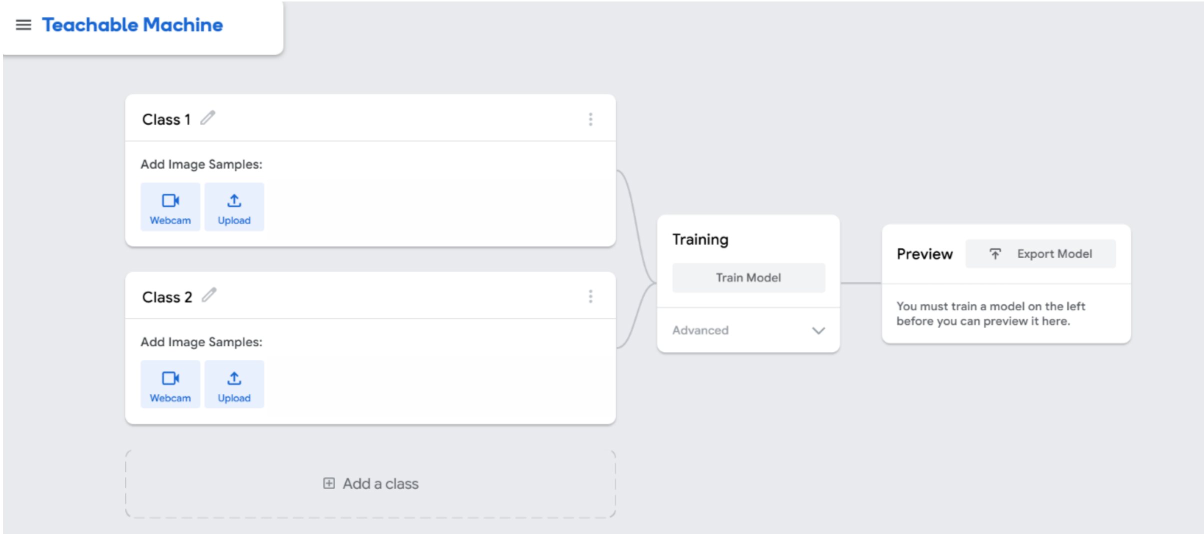


Figure 1.4: Teachable Machine – Upload image to train model

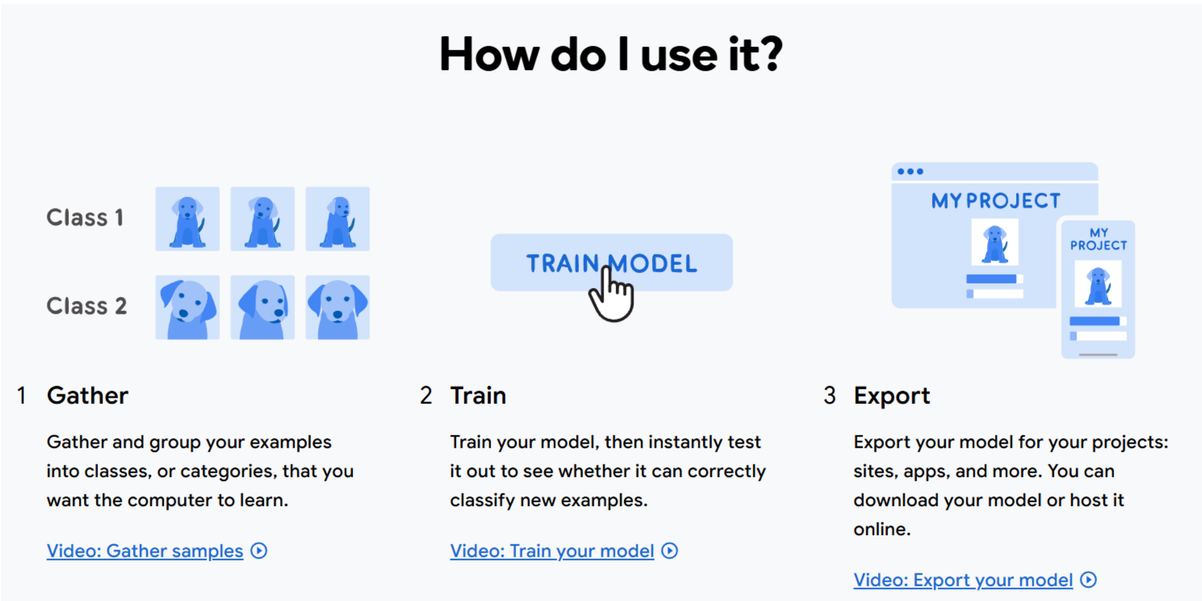


Figure 1.5: Teachable Machine - User guide

1.7 Significance of Project

This project will help users understand more about the local dogs. The image processing process will help the users get accurate dog information, especially for the local dogs. Users can learn more about specific details, such as dogs' lifespans and how to interact with them. Moreover, this study will benefit those who wish to own a dog by helping them figure out how well their preferred dog is and whether it is suitable to feed.

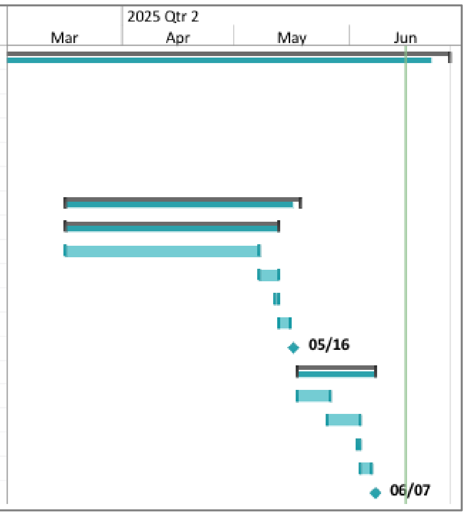
1.8 Project Schedule

Figure 6 shows the progress of this project. Each chapter is divided into several small tasks and has a milestone. Each chapter and the related tasks are marked with the start date, end date, and the duration to complete the tasks.

Task Name	Duration	Start	Finish
FYP Project Schedule	**71 days**	**Mon 24/10/07**	**Sun 25/01/12**
1 Brief Proposal	**8 days**	**Mon 24/10/07**	**Wed 24/10/16**
1.1 Define and identify proposed project	7 days	Mon 24/10/07	Tue 24/10/15
1.2 Submit draft to review	1 day	Wed 24/10/16	Wed 24/10/16
1.3 Make amendment on brief proposal	1 day	Wed 24/10/16	Wed 24/10/16
1.4 Milestone: Upload brief proposal to FYP Management System	0 days	Wed 24/10/16	Wed 24/10/16
2 Full Project Proposal	**21 days**	**Thu 24/10/17**	**Thu 24/11/14**
2.1 Define methodology and app design	13 days	Thu 24/10/17	Mon 24/11/04
2.2 Sumbit draft for amendment review	1 day	Mon 24/11/04	Mon 24/11/04
2.3 Make amendment full proposal	7 days	Tue 24/11/05	Wed 24/11/13
2.4 Milestone: Upload full proposal to FYP Management System	0 days	Thu 24/11/14	Thu 24/11/14
3 Chapter 1 : Introduction	**5 days**	**Fri 24/11/15**	**Thu 24/11/21**
3.1 Enhance full proposal	2 days	Fri 24/11/15	Sun 24/11/17
3.2 Submit draft for amendment	1 day	Mon 24/11/18	Mon 24/11/18
3.3 Make amendment on Chapter 1	2 days	Tue 24/11/19	Wed 24/11/20
3.4 Milestone: Submit Chapter 1 to FYP Management System	1 day	Thu 24/11/21	Thu 24/11/21
4 Chapter 2 : Literature Review	**16 days**	**Fri 24/11/22**	**Fri 24/12/13**

Task Name	Duration	Start	Finish
4.1 Literature review on existing apps and programming languages	3 days	Fri 24/11/22	Tue 24/11/26
4.2 Literature review on databases, frameworks and tools used	3 days	Tue 24/11/26	Thu 24/11/28
4.3 Submit draft for review and comments	1 day	Fri 24/11/29	Fri 24/11/29
4.4 Make amendment on Chapter 2	10 days	Sat 24/11/30	Thu 24/12/12
4.5 Milestone: Upload Chapter 2 to FYP Management System	1 day	Fri 24/12/13	Fri 24/12/13
5 Chapter 3 : Requirement Analysis and Design	**17 days**	**Sat 24/12/14**	**Sun 25/01/05**
5.1 Prepare and conduct Questionnaire	7 days	Sat 24/12/14	Mon 24/12/23
5.2 Analysis data	4 days	Tue 24/12/24	Fri 24/12/27
5.3 App design	3 days	Fri 24/12/27	Tue 24/12/31
5.4 Submit for review and comments	1 day	Wed 25/01/01	Wed 25/01/01
5.5 Make amendment on Chapter 3	3 days	Thu 25/01/02	Sat 25/01/04
5.6 Milestone: Upload Chapter 3 to FYP Management System	1 day	Sun 25/01/05	Sun 25/01/05

Task Name	Duration	Start	Finish
FYP Project Schedule	**190 days**	**Mon 24/10/07**	**Fri 25/06/27**
1 Brief Proposal	**8 days**	**Mon 24/10/07**	**Wed 24/10/16**
2 Full Project Proposal	**21 days**	**Thu 24/10/17**	**Thu 24/11/14**
3 Chapter 1 : Introduction	**5 days**	**Fri 24/11/15**	**Thu 24/11/21**
4 Chapter 2 : Literature Review	**16 days**	**Fri 24/11/22**	**Fri 24/12/13**
5 Chapter 3 : Requirement Analysis and Design	**17 days**	**Sat 24/12/14**	**Sun 25/01/05**
6 Chapter 4 : Development and Implementation	**46 days**	**Mon 25/03/17**	**Sun 25/05/18**
6.1 Develop Application	**41 days**	**Mon 25/03/17**	**Mon 25/05/12**
6.1.1 Create user interface	38 days	Mon 25/03/17	Wed 25/05/07
6.1.2 Internal testing	3 days	Thu 25/05/08	Mon 25/05/12
6.2 Submit draft for review and comments	1 day	Mon 25/05/12	Mon 25/05/12
6.3 Make amendment for Chapter 4	3 days	Tue 25/05/13	Thu 25/05/15
6.4 Milestone: Chapter 4 Completed	1 day	Fri 25/05/16	Fri 25/05/16
7 Chapter 5: Testing and Evaluation	**17 days**	**Sun 25/05/18**	**Sat 25/06/07**
7.1 Target user testing	7 days	Sun 25/05/18	Mon 25/05/26
7.2 Analyze and evaluate results	7 days	Mon 25/05/26	Tue 25/06/03
7.3 Submit draft for amendments	1 day	Tue 25/06/03	Tue 25/06/03
7.4 Make amendment for Chapter 5	3 days	Wed 25/06/04	Fri 25/06/06
7.5 Milestone: Chapter 5 Completed	1 day	Sat 25/06/07	Sat 25/06/07



Task Name	Duration	Start
FYP Project Schedule	**190 days**	**Mon 24/10/07**
1 Brief Proposal	**8 days**	**Mon 24/10/07**
2 Full Project Proposal	**21 days**	**Thu 24/10/17**
3 Chapter 1 : Introduction	**5 days**	**Fri 24/11/15**
4 Chapter 2 : Literature Review	**16 days**	**Fri 24/11/22**
5 Chapter 3 : Requirement Analysis and Design	**17 days**	**Sat 24/12/14**
6 Chapter 4 : Development and Implementation	**46 days**	**Mon 25/03/17**
7 Chapter 5: Testing and Evaluation	**17 days**	**Sun 25/05/18**
8 Chapter 6: Conclusion and Future Work	**12 days**	**Sun 25/06/08**
8.1 Achievement and limitation	7 days	Sun 25/06/08
8.2 Future enhancement	1 day	Tue 25/06/17
8.3 Submit for amendments	1 day	Wed 25/06/18
8.4 Make amendments for Chapter 6	3 days	Thu 25/06/19
8.6 Milestone: Chapter 6 Completed	1 day	Sun 25/06/22

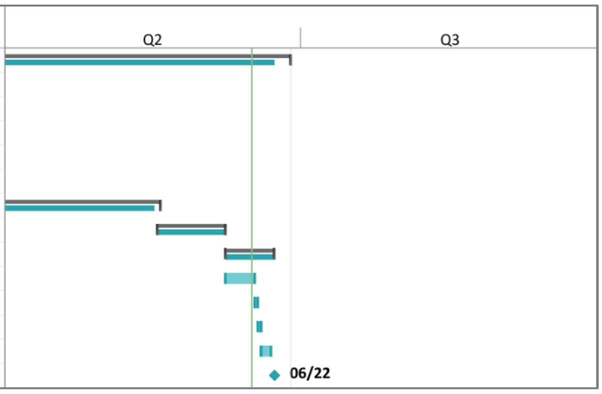


Figure 1.6: Project Schedule

1.9 Expected Outcome

At the end of this project, an Android app for identifying the local dog breeds will be developed. This application will use image processing to let users determine the dog breeds correctly. The user can then learn the standard details of their dogs and special tips for caring for their pets. Hence, the objectives of this project can be achieved.

1.10 Summary

This chapter introduces the proposed PawDetect app, a mobile application designed to help identify dog breeds, especially local ones. The problem statement discusses the challenges the professionals and dog owners face in identifying dog breeds by sight. Besides, it also shows the limitations of existing apps in determining the local dog breeds accurately. The scope defines the target audience and the platform used, while the research objectives focus on building an image-based classifier for breed identification. The methodology follows the Agile Software Development Cycle (SDLC) and uses the Teachable Machine to train the breed identification model. This chapter also outlines the significance of the project, the expected outcomes, and a project timeline.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview

This chapter will review three existing applications from markets, the technology stacks, and the tools we plan to use to develop the application.

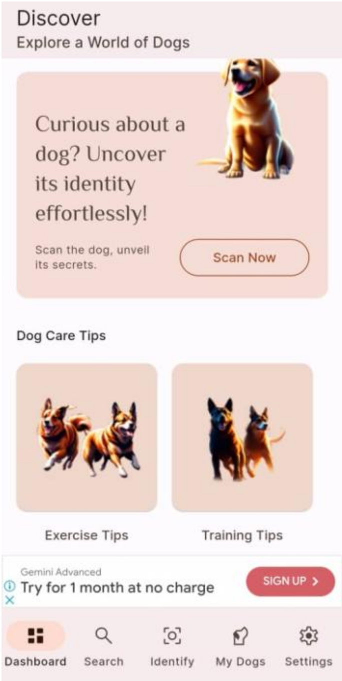
2.2 Review of Existing Solutions

2.2.1 Dog Breed Identifier

The app Dog Breed Identifier, developed by FAMO Connect LLC in 2021, is a versatile tool for dog owners (*Dog Breed Identification—Apps on Google Play, n.d.).* The app allows users to identify dog breeds with ease. Users can capture photos using their device's camera or select existing images from their gallery for identification. Besides, users can search for dog breeds manually by typing their names, catering to those looking for quick information about specific breeds.

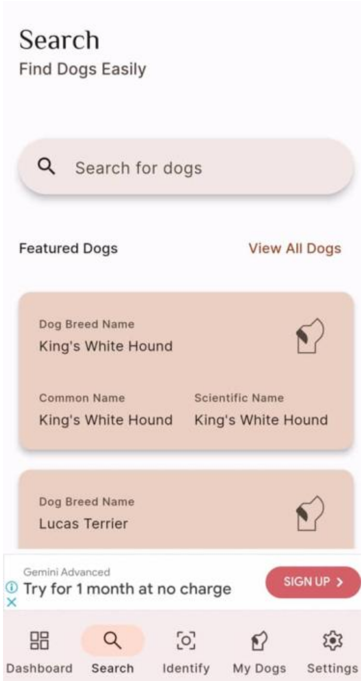
This app includes user-friendly features that enhance its functionality. For example, the dashboard page provides users with helpful knowledge, such as general exercise and training tips. This makes the app also a resource for improving canine care practices. Another key feature is the identification history page. Users can review their identification history and save their favorite breeds. This makes it convenient for users to keep track of the breeds they find most interesting or relevant.

In Figure 2.1(a), the dashboard page is shown where users can choose to scan the dog. On the dashboard page, the exercise tips and training tips are provided.



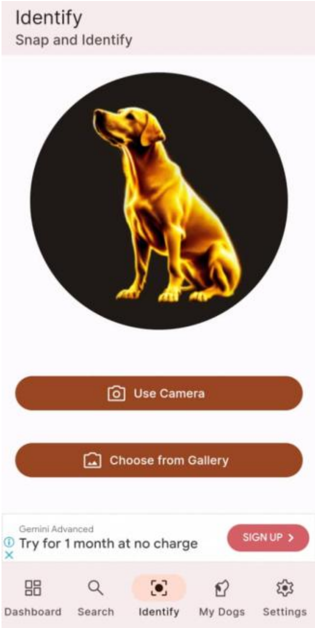
(a) Dashboard page

Figure 2.1(b) displays the search page, where users can manually type the breed's name to search for a dog. A featured dog profile is showcased below the search bar for quick access.



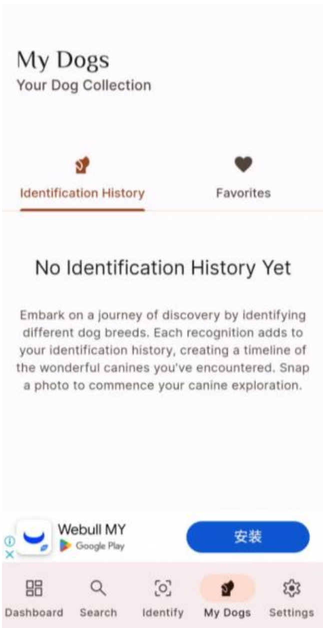
(b) Search page

The landing page is shown in Figure 2.1(c). There are two methods for obtaining the query image, either camera capture or uploading an existing image from the gallery.



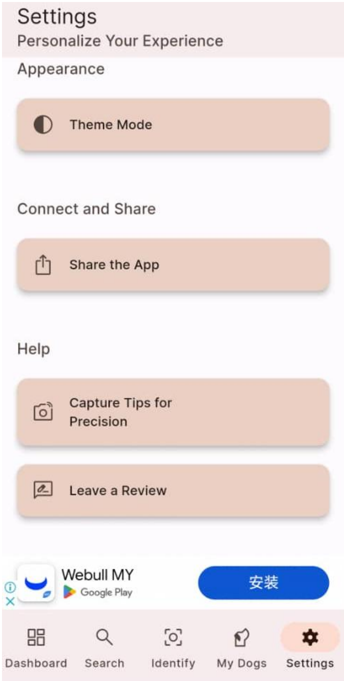
(c) Landing page to scan or upload photos

Figure 2.1(d) shows the identification history. It also shows the user's favorite dog breed.



(d) Identification history page

Figure 2.1(e) shows the setting page. Users can change the app's theme mode, share the app, and leave a review. The page also provides capture tips for precision.



(e) Setting page

Figure 2.1: Functions of the app Dog Breed Identifier

2.2.2 Dog Breed Scanner – Auto Ident

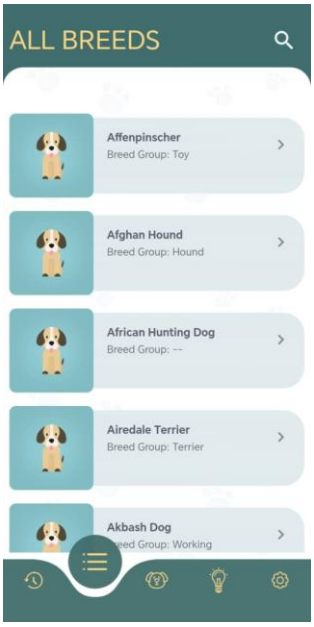
The Dog Breed Scanner – Auto Ident app was launched in 2019 by Saeculum Solutions Pvt Ltd (*Dog Breed Scanner - Auto Ident - Apps on Google Play*, n.d.). This is a valuable tool for dog breed identification and information. It leverages advanced artificial intelligence technology to analyze photos and determine a dog's breed. Users can either upload an image from their gallery or take a picture directly within the app, making it highly accessible and convenient. Besides, users can also access breed information by manually searching for a breed by typing the breed name into the search page.

Beyond identifying breeds, users can explore the fascinating and lesser-known facts about dogs, enhancing their understanding of different breeds. To ensure a personalized experience, the app offers an identification history page where users can review previous searches. This function is helpful for those who want to track and organize the breeds they have identified.

Figure 2.2(a) shows the identification and search history of the dog breed based on the timeline.

(a) Identification and searching history page

Figure 2.2(b) shows the search dog breed page by manually inserting the breed name.

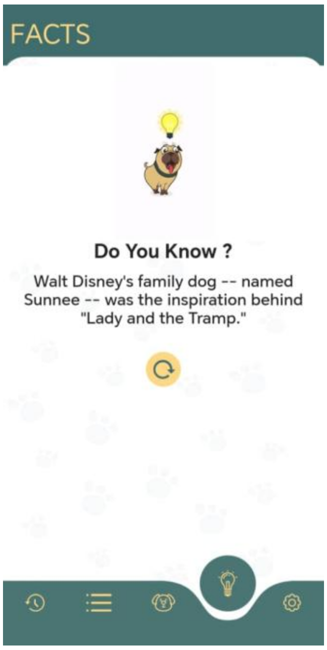


(b) Searching page

Figure 2.2(c) illustrates the application's landing page. Users can click the green button at the bottom right corner to either upload a scanning image by selecting an existing photo from the gallery or capture a live picture.

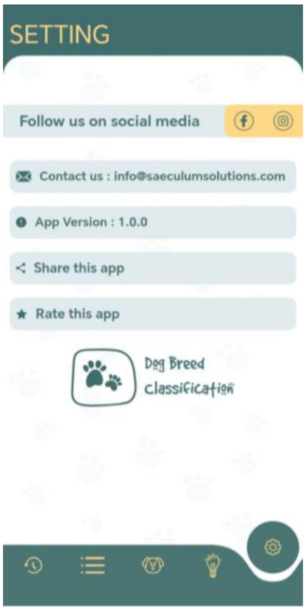
(c) Landing page to find dog breed

Figure 2.2(d) presents the info page, where users can view the dogs' facts and refresh for new information.



(d) Info page

Figure 2.2(e) illustrates the settings page, which provides contact information and details about the app. Additionally, users can leave reviews and rate the app directly from this page.



(e) Setting page

Figure 2.2: Functions of the app Dog Breed Scanner

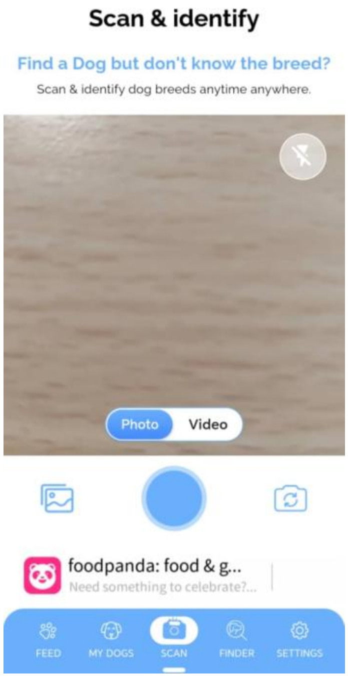
2.2.3 AI based Dog Breed Identifier

AI based Dog Breed Identifier is a dog breed identification tool released in 2022 by Differenz Solutions Pvt. Ltd. (*AI Based Dog Breed Identifier – Apps on Google Play*, n.d.). The application lets users take photos or videos of the dogs to identify the breed accurately, or users can also upload images from their gallery. The breed information page includes a detailed overview of each breed, its history, and specific care tips, making it a thorough resource for dog lovers. This app stands out with its ability to create detailed dog profiles. Users can record essential information such as the dog's breed, weight, gender, and specific details, including health status, dietary preferences, and exercise preferences.

A unique feature of AI based Dog Breed Identifier is the guidance for first-time dog owners. The app includes a quiz with several questions that help users determine the most suitable dog breed based on their lifestyle, preferences, and living conditions. This makes it an invaluable resource for individuals looking to adopt their first dog, ensuring they choose a breed that matches their environment.

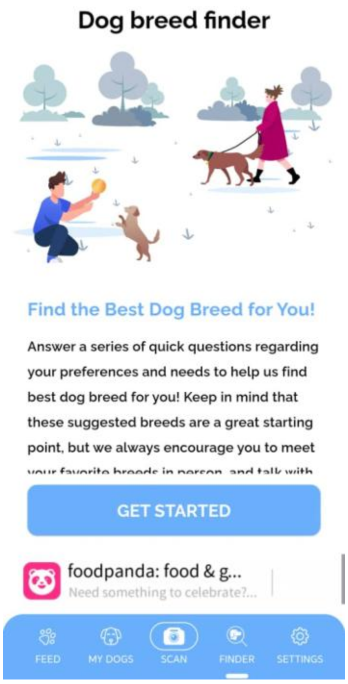
In addition, the app provides helpful information on dog behaviors, including how to respond to a dog's mood. Users can learn about the signs of anger, happiness, or sadness in their dogs and receive tips on how to calm them. The app offers a comprehensive solution for new and experienced dog owners. It combines practical identification functions with detailed and specific breed information, making it an all-in-one tool for anyone interested in dogs.

Figure 2.3(a) presents the landing page, where users can either upload a live photo or video to identify the dog's breed or select an existing photo or video from their gallery.



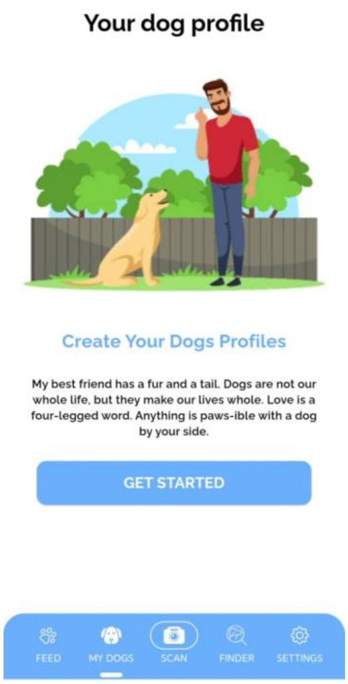
(a) Landing page for scanning the dog breed

Figure 2.3(b) illustrates the quiz page for users to find their suitable dog breed.



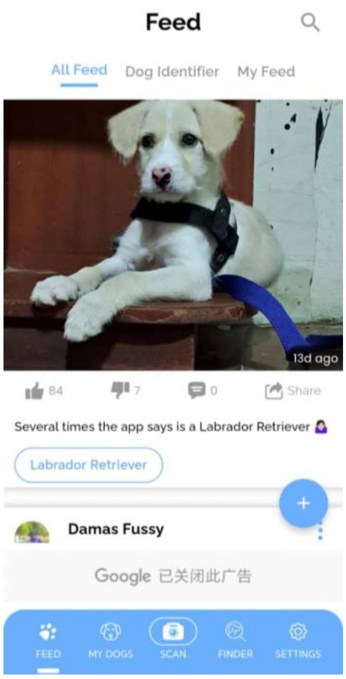
(b) Quiz page to find the suitable dog breed

Figure 2.3(c) depicts the dog profile page, which allows users to create and manage individual profiles for each dog.



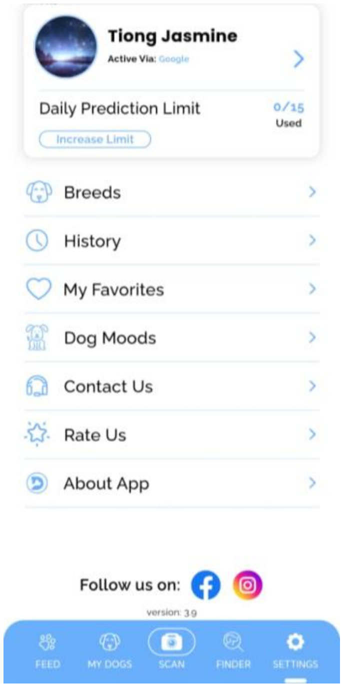
(c) Dog profile page

Figure 2.3(d) shows the community page, where users can share their dogs or the detection results.



(d) Community page

Figure 2.3(e) shows the settings page where users can view their daily identification limits, search the breeds, and view the identification history. Besides, users can view their favorite breeds, knowledge about dog moods, and contact and information about the app



(e) Settings page

Figure 2.3: Functions of the AI based Dog Identifier

2.2.4 Comparison Table Between Existing and Proposed Applications

The table below compares proposed applications with three existing platforms, languages, and features.

Application Name		Dog Breed Identifier	Dog Breed Scanner – Auto Ident	AI based Dog Breed Identifier	Proposed Application (PawDetect)
Platform	Android	✓	✓	✓	✓
	iOS	✓	×	✓	×
Language	English	✓	✓	✓	✓
Features	Identify dog breeds by scanning or taking a picture	✓	✓	✓	✓
	Identify dog breeds by uploading a video	×	×	✓	×
	Show identification history	✓	✓	✓	✓
	Have search function	✓	✓	✓	✓
	Create dog profile	×	×	✓	✓
	Find a suitable dog by quiz	×	×	✓	×
	Provide general facts and tips about dogs	✓	✓	✓	✓
	Provide dog breed information.	✓	✓	✓	✓
	Provide tips to take care of the dog	×	×	✓	✓
	Let other users share their pets	×	×	✓	×

2.2.5 Strengths and Drawbacks of Existing Applications and Proposed Application

The table below presents the strengths and weaknesses of three existing applications and the proposed application.

Application Name	Dog Breed Identifier	Dog Breed Scanner – Auto Ident	AI based Dog Breed Identifier	Proposed Application
Strengths	Direct button for users to know the breed details on the result page	The interface design is simple and easy to use	Suitable for the first time dog lovers to find their suitable dog	Simple and well-designed interface
	Provide general exercise and training tips		Help users create a profile for their dogs	Detailed profile for each dog
	The page is easy to use		Provide information about dog moods and how to calm the dog	Specific breed information is provided
Drawbacks	Less specific information for the dog breed	The button "Know more on Wikipedia" on the result page does not work	The dog's information is too long and a burden to read	Only can use photos to detect the breed
		Only provide general information such		

		as height, weight and lifespan		

2.3 Review of Existing Programming Languages

2.3.1 Java

Java is one of the most widely used programming languages for Android app development and is officially supported by Android Studio. It offers a robust and versatile platform for application development. Java emphasizes object-oriented programming, which promotes modularity and code reusability. The extensive Java library provides a vast collection of pre-built classes and methods, saving developers time and effort. Besides, a large and active community of developers contributes to Java's continuous development and provides resources, tutorials, and support.

2.3.3 Kotlin

Kotlin is a modern programming language recommended for Android development. Its concise and expressive syntax makes it less error-prone and easier to write than Java. Kotlin's strong type system helps prevent common runtime errors, leading to more reliable applications. Additionally, Kotlin is compatible with Java, ensures a smooth transition of existing projects, and allows access to a vast ecosystem of libraries and frameworks. Kotlin has multiplied, and more resources are becoming available. It has emerged as a compelling choice for modern software development.

2.3.4 C++

C++ is a powerful, high-performance programming language widely used for system, game, and application development requiring direct hardware interaction. It can handle low-level operations and give developers fine-grained control over performance, making it ideal for resource-intensive tasks. C++ also supports object-oriented programming and offers flexibility to create complex and scalable applications. In addition, its portability allows programs to run across multiple platforms.

2.3.5 Comparison Table Between Existing Programming Languages

As shown in the table below, the strengths and drawbacks of three programming languages are summarized.

Programming Languages	Java	Kotlin	C++
Strengths	Strong community and extensive resources	Modern syntax improves readability	It can run virtually on any platform
	Good performance for native apps	Interoperable with Java, allowing gradual migration	Can handle resource-intensive tasks
Drawbacks	Verbox syntax leads to more code and the potential for errors	Smaller community and library	It takes longer time to write code due to its complexity
	Requires more effort to master	The performance of the code may be slower	Limited Android support

2.4 Review of Existing Databases

2.4.1 Firebase Real-time Database

Google provides a cloud-based Firebase platform to make creating web and mobile applications more efficient. Its services include authentication, cloud functions, real-time databases, and other technologies. Firebase allows the server and the devices to synchronize data in real-time. Its main benefit is the smooth interaction with other Firebase services, such as Analytics and Authenticator, which streamlines web and mobile application development. For real-time apps without an extensive backend infrastructure, Firebase is especially well-suited.

2.4.2 SQLite

SQLite is a lightweight database that offers a simple and efficient solution for storing and managing data within applications. SQLite requires no configuration as a serverless solution, simplifying integration into mobile applications. It supports complex queries with SQL syntax, providing a flexible and familiar interface for developers with relational database experience. However, its limited scalability and lack of advanced features may not be suitable for large-scale or high-performance applications. SQLite is popular when data synchronization with a cloud database is unnecessary.

2.4.3 MongoDB Atlas

MongoDB Atlas is a cloud-based database offering a flexible and scalable NoSQL solution. This makes it well-suited for unstructured or semi-structured data. Its scalability and high availability make it a preferred choice for applications with rapidly growing datasets. MongoDB Atlas provides high-performance and robust security features. However, its reliance on internet connectivity can be a drawback for specific projects. It also may have a steeper learning curve compared to relational databases and can cost more for large-scale deployments. It is ideal for flexible data storage, scalability, and high-performance applications.

2.4.4 Comparison Table of Existing Databases

The table below highlights the strengths and weaknesses of three existing databases.

Database	**Firebase Real-time Database**	**SQLite**	**MongoDB Atlas**
Strengths	Integration with other Firebase services like Authenticator	No server required	No SQL database, flexible to dynamic structured data
	Built-in security rules to protect data	Support complex queries	Scalable cloud-based solution
	It can work offline, syncing data when back online	Lightweight and embedded directly into Android apps	Powerful query capabilities for complex data analysis
Drawbacks	It can be costly for large-scale applications	No real-time capabilities	More complex to set up

	Less flexible querying	No built-in security measures	Depends on internet connection

2.5 Review of Existing Frameworks and Libraries

2.5.1 Teachable Machine

Teachable Machine is a user-friendly web-based tool developed by Google to allow users to create machine learning models without requiring advanced coding knowledge. Its intuitive interface makes it accessible for beginners. The Teachable Machine supports image, audio, and pose classifications. The tool leverages transfer learning to build accurate models. These models can be integrated into various projects, making machine learning accessible to a broader audience and enabling creative applications across different fields. However, the Teachable Machine has some limitations. The quality of the output model depends on the dataset provided, which may affect accuracy. It also does not allow fine-tuning or detailed control over the training process. The Teachable Machine is ideal for small projects but may not be sufficient for advanced machine learning needs.

2.5.2 TensorFlow Lite

TensorFlow Lite is a versatile and lightweight machine learning framework widely used in the industry for mobile and embedded devices. It allows developers to install machine learning frameworks on various devices, including smartphones, tablets, and microcontrollers. By optimizing models for low latency and small binary size, TensorFlow Lite facilitates on-device inference, providing a seamless and efficient user experience. This technology empowers developers to create intelligent applications that can perform tasks like image recognition, object detection, and natural language processing directly on the device, even without an internet connection. However, the steep learning curve of TensorFlow Lite can be a barrier for beginners since it requires a solid understanding of machine learning concepts and programming. The high flexibility of TensorFlow Lite makes it suitable for developers aiming to build sophisticated and scalable machine-learning systems tailored to their specific needs.

2.5.3 Open Source Computer Vision Library (OpenCV)

OpenCV is a robust open-source library that offers a wide range of computer vision functions and algorithms. It is extensively utilized for applications including motion tracking, object detection, face recognition, and image and video processing. OpenCV is a valuable tool for developers working on computer vision applications since it provides a wide range of real-time picture analysis and manipulation capabilities. OpenCV supports several programming languages, including Python, Java, and C++, and is highly performance-tuned. Because of this, it can be used for cross-platform programming. For advanced features, developers must combine OpenCV with other frameworks like TensorFlow because its primary focus is computer vision rather than machine learning. Although it can be rugged for newcomers, developers looking for low-level control over image processing can still benefit greatly.

2.5.4 Comparison Table Between Existing Frameworks and Libraries

As presented in the table below, the strengths and drawbacks of three existing frameworks and libraries are summarized.

Framework/Library	Teachable Machine	TensorFlow Lite	Open Source Computer Vision Library (OpenCV)
Strengths	No coding required	Optimized for mobile and embedded devices	Cross-platform compatibility
	Direct export for Android apps	Extensive community support and documentation	Extensive community support and documentation
	Accessible from any device with a browser	Allows for customization of models and deployment on various platforms	Extensive functions for image processing and computer vision
Drawbacks	Not suitable for complex models	Steeper learning curve	Require more programming effort
	Require internet connection for training and deployment	Requires knowledge of machine learning and Python programming	Not suitable for complex neural network

2.6 Other tools used

There are some other tools are planned to be used for the development of the proposed applications:

2.6.1 Android Studio

Android Studio is the official integrated development environment (IDE) for Android app development. The IDE provides robust features, including a visual layout editor, intelligent code completion, and built-in debugging tools. These characteristics lessen the possibility of mistakes and streamline the app development process. Android Studio can also be directly integrated with Firebase, ensuring a smooth setup for real-time database management, authentication, and other backend services. Its emulator support allows for efficient testing on various devices and screen sizes, critical for ensuring the application delivers a consistent user experience. Because it supports Java, Kotlin, and C++, Android Studio is a well-liked option for developers creating various Android applications.

2.6.2 Figma

Figma is a powerful and collaborative web-based design tool that has completely transformed how designers work. It is essential to developing the proposed application's user interface and user experience. Figma allows teams to design, edit, and share designs in real-time to guarantee that the design is user-friendly and visually appealing. Its vast collection of design tools makes creating wireframes, mockups, and interactive prototypes easy. The extensive library of templates and plugins can accelerate the design process, making it easier to produce high-quality images quickly.

2.7 Critical Review

2.7.1 App Features

The proposed application PawDetect is designed with a user-friendly interface that makes it accessible to a wide range of users. Its simple interface reduces the need for guidance, allowing users to interact easily with the app. The application provides a smooth user experience by enabling users to take pictures of a dog or upload existing photos to identify its breed. Once identified, the app displays detailed breed information without requiring additional button clicks, increasing the efficiency and convenience of the users.

Furthermore, including identification history features provides a valuable reference for users, allowing them to review breeds that have already been scanned. Users are given comprehensive information that covers general and breed-specific details. General information includes basic details such as the breed's average weight, height, and origin. Specific details focus on practical tips for caring for the breed, such as recommended activity and diet. This strategy ensures that users can access actionable and educational content, making the app helpful and informative.

In addition, the proposed application introduces a dog profile creation feature, which allows users to manage information about their pets efficiently and systematically. Each profile is divided into four sections: general information, health information, dietary preferences, and activity preferences. This structured approach ensures that owners with multiple pets can manage their care requirements without confusion. By centralizing important information, the profile system encourages responsible pet management by making it simple for users to monitor and maintain their pets' health.

Fun facts and general tips are another component of this proposed app. This element makes the app more educational and entertaining, suitable for new and experienced dog owners. Fun facts include unusual facts about different breeds, while general tips could cover topics like training methods, seasonal care, and how to recognize signs of common health issues. This feature promotes better knowledge of canine companions and enhances the user experience.

2.7.2 Programming Language

Kotlin is the most suitable choice for developing the PawDetect app. Kotlin is the default and recommended language in Android Studio. It offers modern features like concise syntax and reduced boilerplate code, improving readability and productivity. Although adopting Kotlin requires some learning, its interoperability with Java allows the developer to apply existing knowledge while aligning with current Android Studio practices.

Java is a long-standing Android development language and offers extensive libraries and documentation. It benefits the developer since they are already familiar with Java. However, using Java in a Kotlin-focused environment may lead to extra setup and less efficient use of modern tools in Android Studio.

C++ is suitable for tasks requiring high computational efficiency. Its low-level capabilities and direct hardware access offer unmatched performance. However, its syntax and memory management can be a challenge to handle. C++ is not widely used in Android development because it lacks the community and support. It is best suited for performance-critical components rather than the user interface design or general app logic.

Kotlin is the best language to use while creating the PawDetect app. Java offers familiarity and a solid base, but Kotlin is more aligned with modern Android development practices and leverages the developer’s existing Java knowledge. C++ is advised only if complex computational activities are involved.

2.7.3 Database

Firebase Real-time Database is a compelling choice for the proposed application, PawDetect. It is seamless in integration with Android Studio and provides real-time data synchronization. The primary strengths of Firebase are its simplicity and ease of use, as it eliminates the need to set up and manage a backend server. This makes it ideal for projects with limited development time or resources. Additionally, it can integrate with other Firebase services, such as Authenticator and Analytics, and offers a cohesive ecosystem that simplifies the development process while enhancing app functionality and user experience.

However, Firebase also has limitations that must be considered. Firebase’s relatively basic querying capabilities make it less suitable for complex data or advanced analytics. Besides, the pricing model can be costly as the app scales, particularly for applications with high data traffic or extensive read-and-write operations.

Despite these drawbacks, Firebase aligns well with PawDetect’s needs. Its real-time capabilities can support potential future features such as community interactions. Its cloud-based nature ensures data consistency across devices. The minimal setup requirements make Firebase a practical choice for a small team.

2.7.4 Frameworks and Libraries

Teachable Machine is a practical and accessible tool for integrating machine learning into PawDetect. Its simple interface allows developers to train machine learning models without coding or AL knowledge. This makes it an excellent choice for solo developers or those with limited experience in machine learning. Teachable Machine allows developers to export models directly for Android applications, simplifying integration with tools like Android Studio and reducing development time. For PawDetect, which focuses on image classification for dog breed identification, the Teachable Machine provides a straightforward way to create a functional model quickly.

However, Teachable Machine has some limitations that must be considered. Its training process relies on the quality and diversity of the dataset. This could impact the model's accuracy if not carefully curated. Additionally, it offers limited customization, meaning developers have minimal control over the underlying training parameters or model architecture. This could be a drawback if the application requires more sophisticated machine learning capabilities. Besides, Teachable Machine may not be as scalable as more robust frameworks like TensorFlow Lite for handling larger datasets or more complex models.

Overall, Teachable Machine aligns well with PawDetect's goals. It allows for a quick and effective implementation of breed recognition without needing advanced technical expertise. Its simplicity and convenience make it an ideal choice for this project.

2.8 Summary

This chapter examines the three existing dog breed identification applications: Dog Breed Identifier, Dog Breed Scanner - Auto Ident, and AI based Dog Breed Identifier. It reviews and analyzes the app's functions, strengths, and weaknesses. This chapter also explores programming languages, databases, frameworks, and libraries to determine the best tools for this project. Android Studio and Figma are used to develop the app and design the user interface respectively. The critical review section justifies the choice of Java language for application development, Firebase for real-time database management, and Teachable Machine for machine learning in the proposed PawDetect app.

CHAPTER 3: REQUIREMENT ANALYSIS AND DESIGN

3.1 Introduction

This chapter will discuss the requirement analysis and interface design. A questionnaire was conducted to gather user requirements on the application features and design.

3.2 Analysis

We conducted an English-language Google Form questionnaire to gather the user requirements for the proposed application. The analysis collected 33 responses using convenience sampling. The survey consisted of four sections: demographics, experience with the existing app, desired features and design, and overall feedback.

3.2.1 Section 1: Demographics

The demographics section gathered the age, gender, race, employment status, respondents' preferences for owning a dog, and respondents' familiarity with dog breeds. Figure 3.1 – Figure 3.6 shows the result for the demographics section. Of the 33 respondents, the largest age group was 23-29, comprising 16 individuals (48.5%). This was followed by the 18-22 age group with 16 respondents (30.3%). The 40-49 age group included five respondents (15.2%). One respondent (3.0%) was aged 30-39, and another (3.0%) was over 50.

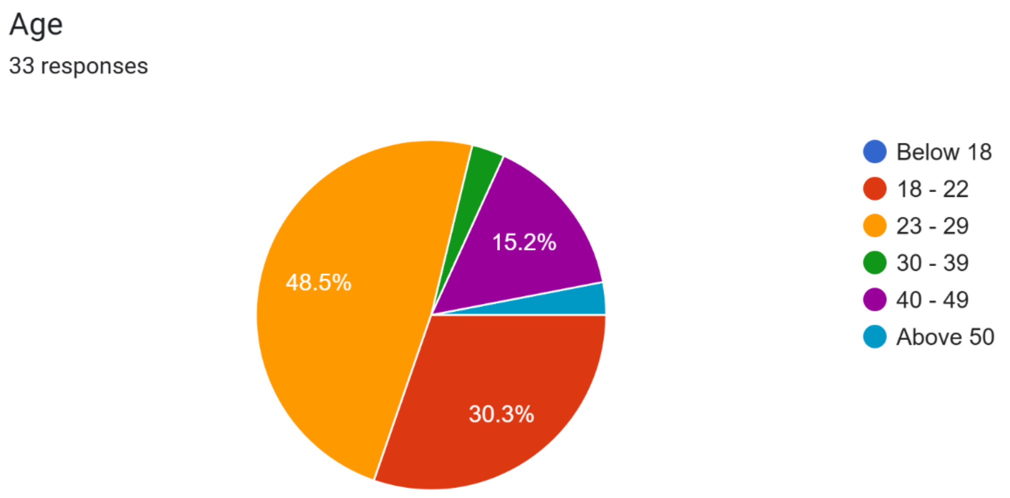


Figure 3.1: Pie chart – Age distribution

For the gender distribution, nine (27.3%) respondents are male, and 24 (72.7%) are female.

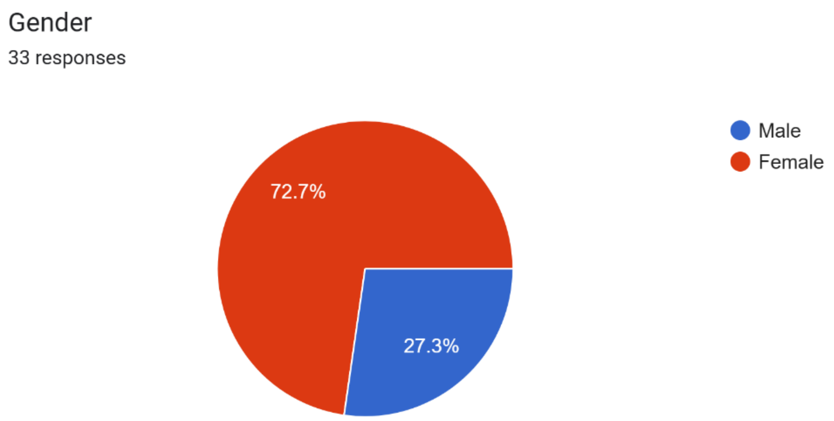


Figure 3.2: Pie Chart – Gender distribution

In this survey, 26 participants (78.8%) are Chinese, 3 are Malay (9.1%), and 2 are Iban (6.1%). Dusun and Melanau have one respondent (3.0%), respectively.

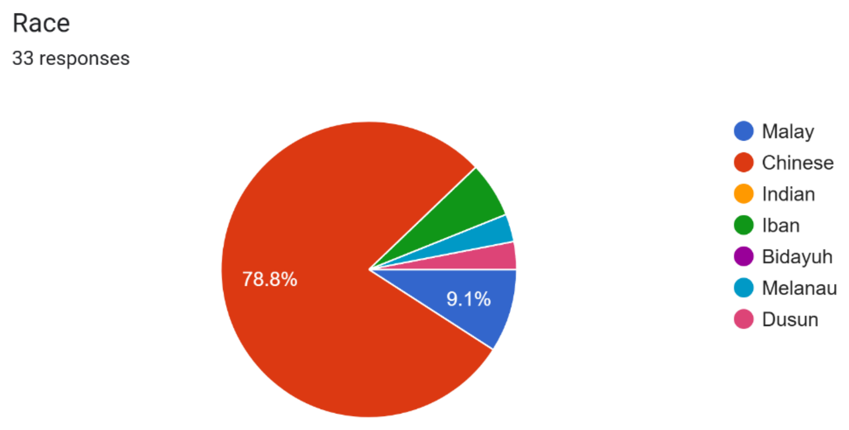


Figure 3.3: Pie Chart – Race distribution

Of the 33 participants, 24 (72.7%) were students, 7 (21.2%) were employed, 1 (3.0%) was unemployed, and 1 (3.0%) was self-employed.

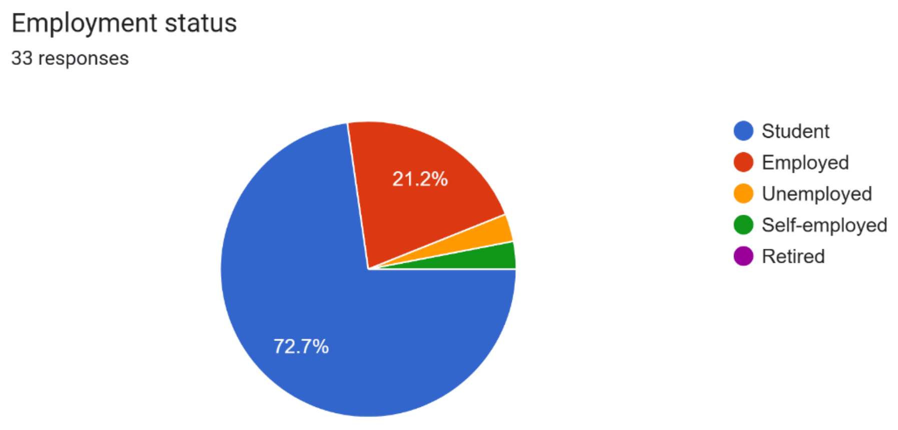


Figure 3.4: Pie Chart – Employment status distribution

The survey revealed that 42.4% of respondents own or plan to acquire a dog. Conversely, 19 respondents (57.6%) indicated they do not own a dog and have no plans to do so.

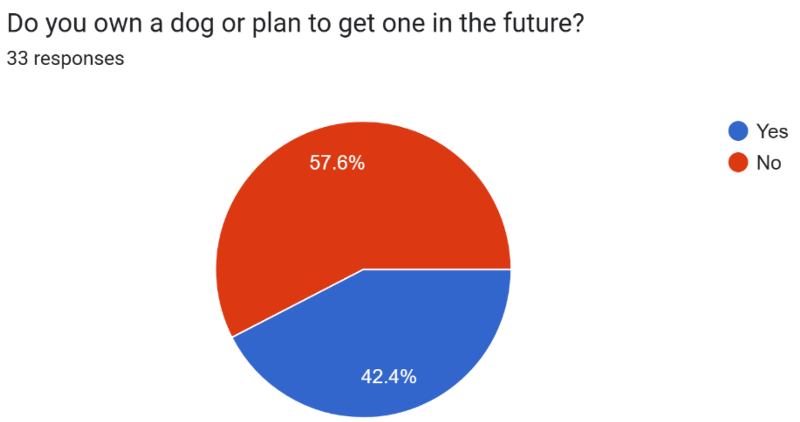


Figure 3.5: Pie Chart – Experience with dog

The respondents are asked to determine their familiarity with dog breeds using the Likert scale (1—Not familiar at all, 2—Slightly familiar, 3—Neutral, 4—Familiar, 5—Very familiar). The mean score of this question is 2.42, which highlights that the respondents are slightly familiar with the dog breeds.

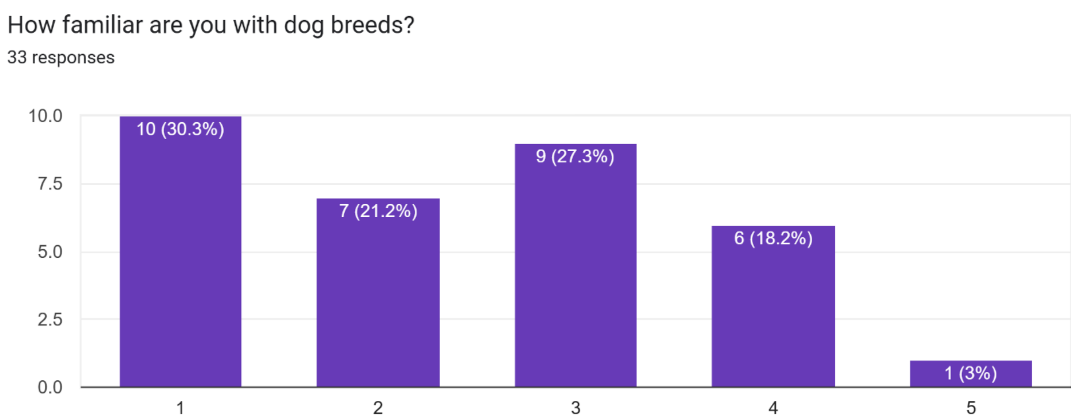


Figure 3.6: Bar Chart – Familiarity with dog breeds

3.2.2 Section 2: Experience with Existing App

Section 2 focuses on the respondents' experience with the existing dog breed identification app. In the first question, all 33 respondents had no experience using an app before the survey (refer to Figure 3.7).

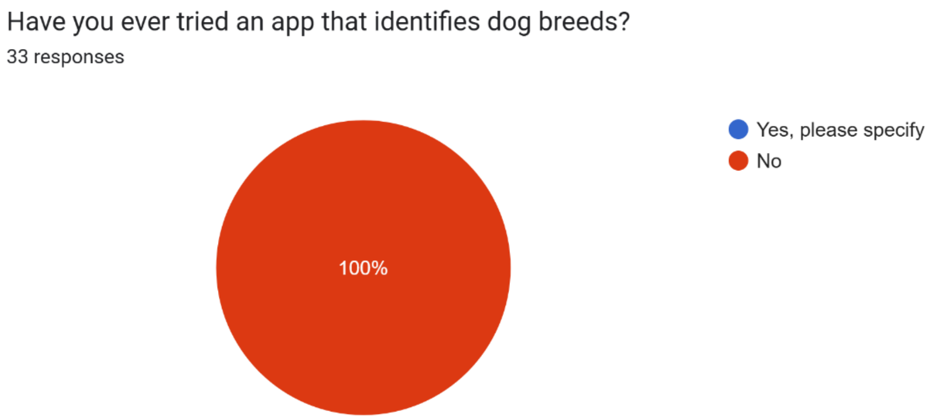


Figure 3.7: Pie Chart – Experience of trying the existing app

As shown in Figure 3.8, 87.9% of respondents are interested in identifying the breed of dog they saw or own. 12.1% of respondents do not have this thought about placing the dog they saw or own.

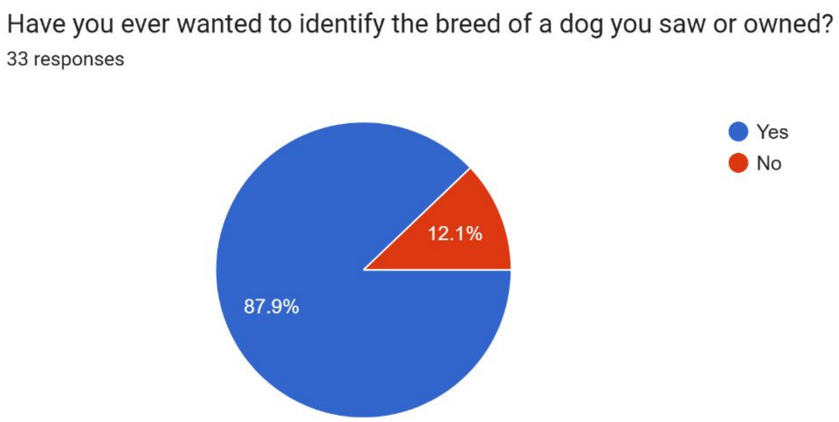


Figure 3.8: Pie Chart – Thoughts to identify dog breeds

The multiple-choice question concerns the respondents' expectations about a dog breed identification app's feature (refer to Figure 3.9). The most highly expected feature, selected by 30 respondents, is identifying the breed quickly using a photo. The second most expected feature is to provide detailed breed information such as lifespan and size. Meanwhile, 26 respondents indicated they expect the app to offer tips on caring for the breed, including feeding and exercise. The least anticipated feature by the respondents is to suggest similar breeds if the app cannot identify the breed.

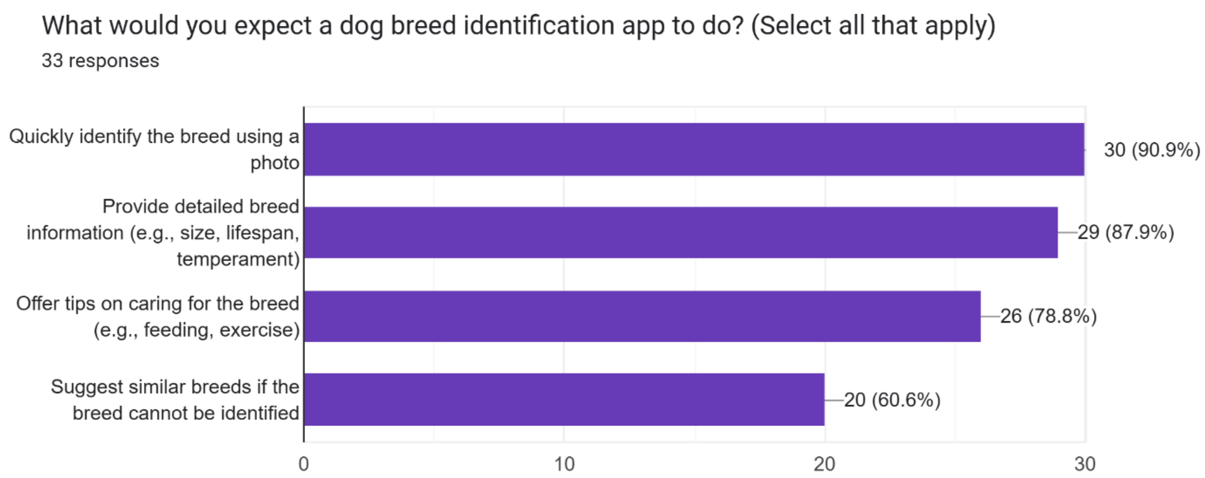


Figure 3.9: Bar Chart – Expectations on dog breed identification app

Next, we want to know the dog breed information that respondents wish to provide. Referring to Figure 3.10, the most popular selection was feeding and care tips, which 23 respondents selected. There were two choices with the same number of respondents, of which 22 chose. One is temperament and behavior traits, while the other is health risks or common medical conditions. The selection exercise and activity needs, as well as another selection history or origin of the breed, were chosen by 16 respondents.

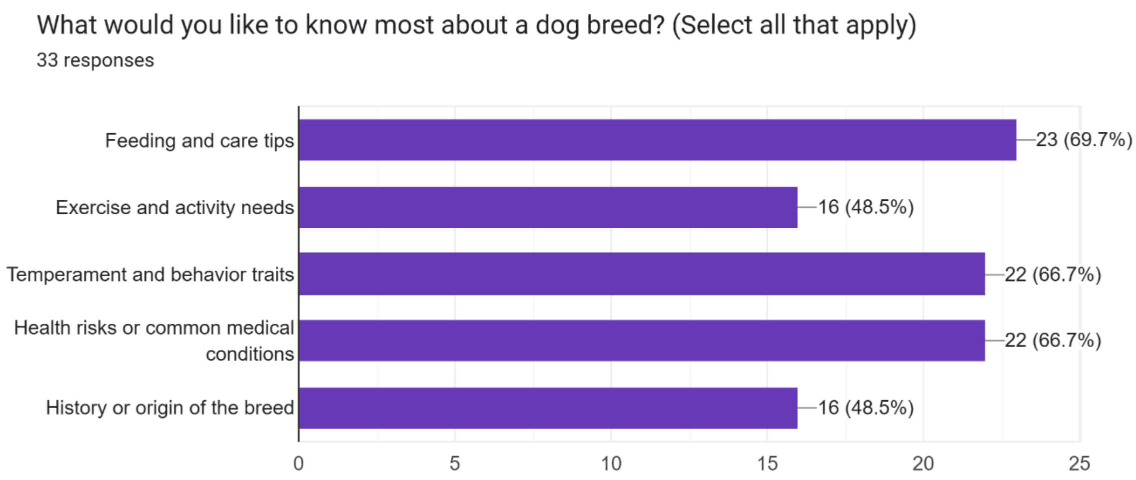


Figure 3.10: Bar Chart – Things want to know about dog breed

The survey asked respondents how they preferred to interact with the app for dog breed identification (refer to Figure 3.11). The most popular option was to use both live and existing photos, chosen by 63.6% (21 respondents). Taking a live photo was the second most popular option, selected by 27.3% (9 respondents). Uploading an existing photo was the least popular option, with only 9.1% (3 respondents) choosing it.

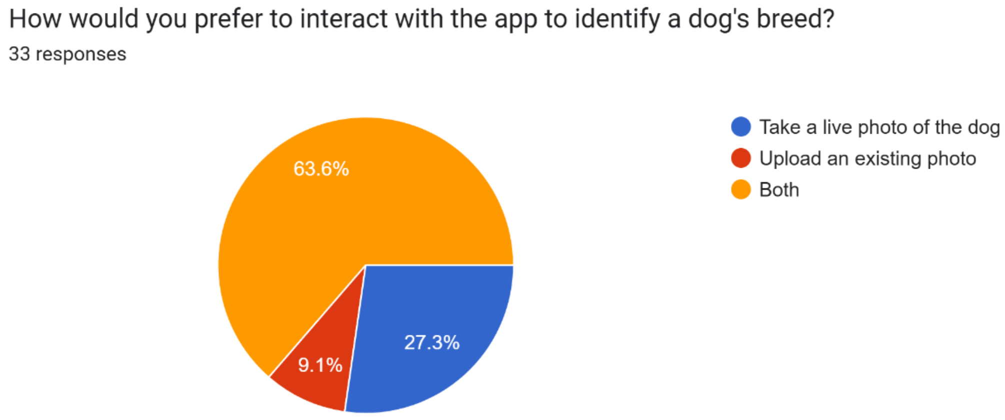


Figure 3.11: Pie Chart – Way to identify a dog breed

We asked a multiple-choice question to understand whether the respondents would prefer additional features of the app (refer to Figure 3.12). Twenty-four respondents chose the feature recommendation for nearby shelters or vets. The second-highest choice is saving breed profiles for future reference. Twenty respondents chose to have notifications about dog care tips and reminders. The least preferred additional feature is connecting with local dog owners for advice. One respondent answered that no extra features are preferred since the only interest is to know what that animal is.

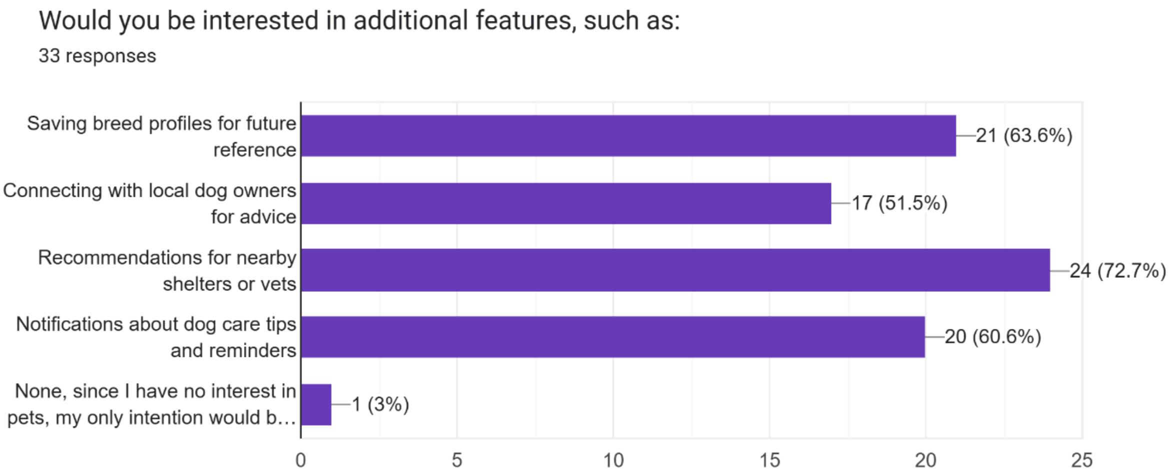


Figure 3.12: Bar Chart – Additional features

The second-to-last question in this section explored the reasons for trusting the app's breed identification accuracy (refer to Figure 3.13). Respondents expressed the most potent trust in the app when it relied on verified information sources, with 27 respondents citing this as a key factor. Detailed explanations for breed identification results were the least frequently cited factor influencing trust. High accuracy ratings and positive user reviews/feedback were also important factors, ranking second and third in respondent preference.

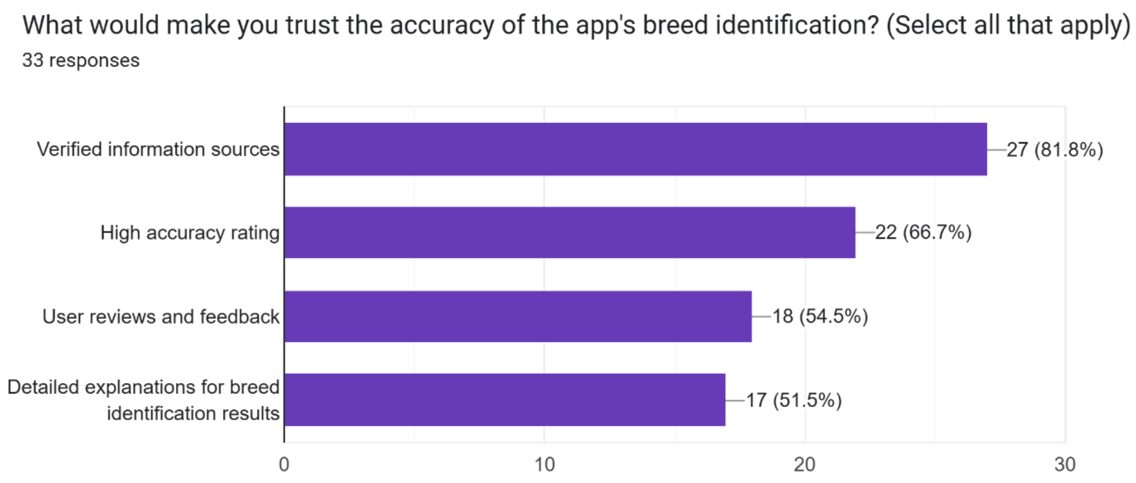


Figure 3.13: Bar Chart – Reason to trust the accuracy

An open-ended question ends this section—the respondents' thoughts about the focus on the local dog breed and the reasons. Most respondents gave answers that focused on local dog breeds, which is essential since they have a lot of local dogs and are being ignored. Some respondents say that the local dog is unknown to them, and they want to know the dog's breed. Some respondents highlight that people should know what kind of dog they want. Local dogs are unwanted and homeless since they are not branded breeds, although the local dogs are intelligent and can take care of home security. Some respondents claim that loving and caring for a pet dog is regardless of its breed. A few of the respondents have no comments on this question.

3.2.3 Section 3: Desired Features and Design

This survey section focused on gathering respondents' preferences for the app's features and design. The first was a multiple-choice question (refer to Figure 3.14) about desired app features. The image scanning feature for dog breed identification emerged as the most popular choice, with 30 out of 33 respondents selecting it. Notifications for dog care tips and reminders were the least popular, with only 12 respondents expressing interest. Other features suggested included information on dog breeders or trainers and cute pet costume filters. The top five features selected by respondents are presented in Table 3.1.

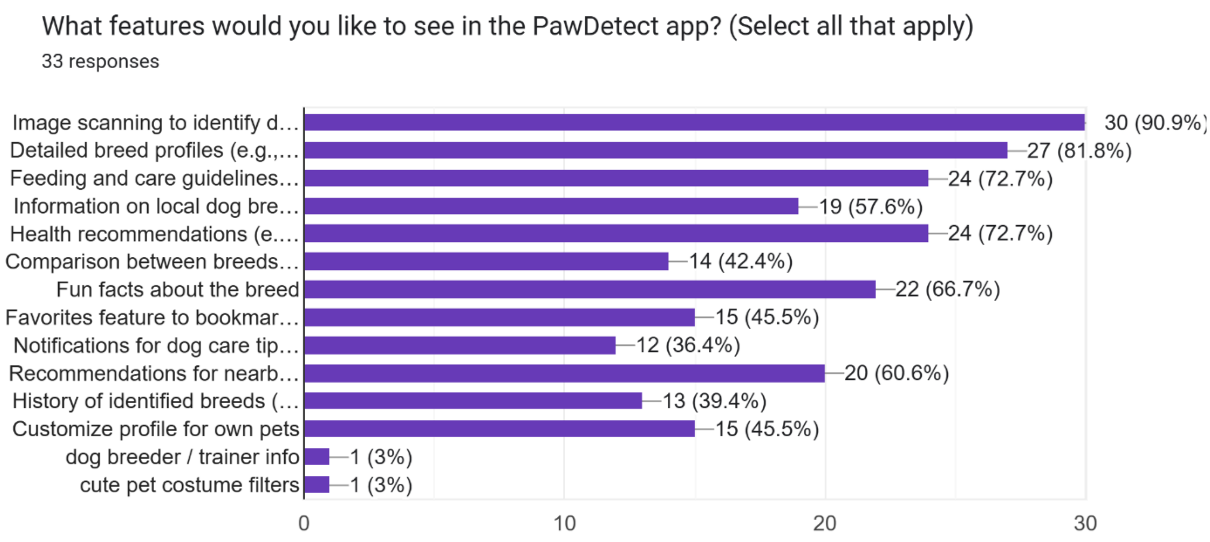


Figure 3.14: Bar Chart – Ranked features of PawDetect

Top Five Features	**Count**
Image scanning to identify dog breeds	30
Detailed dog breed profiles (e.g., size, lifespan, temperament)	27
• Feeding and care guidelines specific to the breed • Health recommendations (e.g., common diseases of the breed)	24
Fun facts about the breed	22
Recommendations for nearby shelters and vets	20

Table 3.1: Top five features chosen

Respondents (28 respondents) indicated that simple navigation with clear menus would significantly enhance the app's user-friendliness. Twenty-two respondents cited three features—visual cues like icons and animations, short text instructions, and an intuitive design requiring minimal learning effort—each. Personalized options, such as saving favorite breeds, were the least frequently cited factor, with only 14 respondents selecting them.

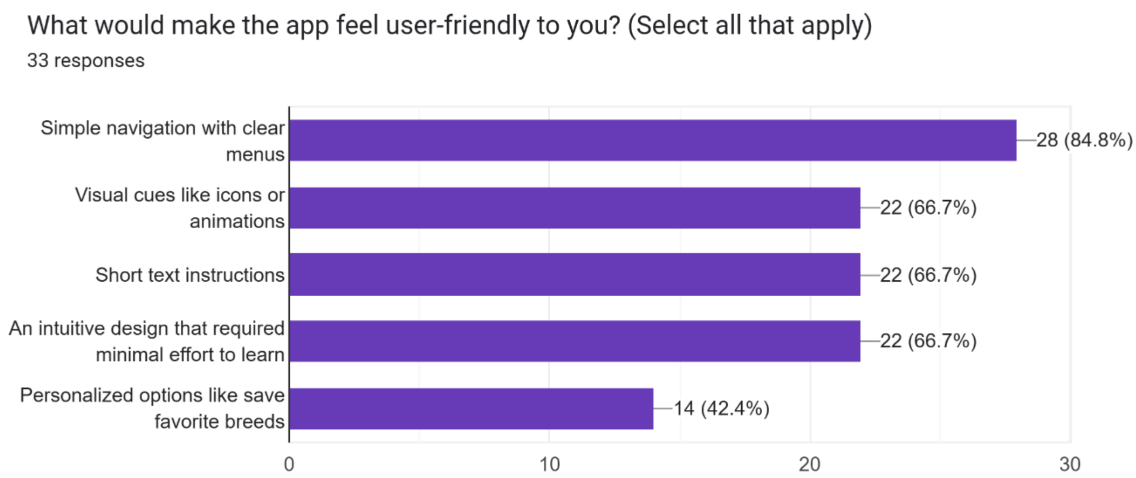


Figure 3.15: Bar Chart – Reasons for feeling user-friendly

Responding to the third question regarding personalized context based on dog breeds, most respondents (51.5%) preferred general and breed-specific information. A significant portion (36.4%) favored receiving tips and advice tailored to their dog's breed, while a smaller group (12.1%) only preferred general information.

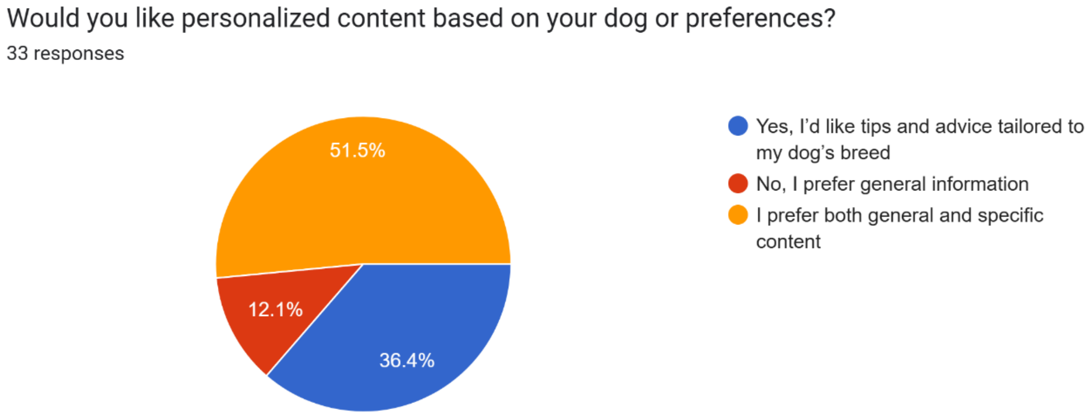


Figure 3.16: Pie Chart – Interest in personalized content

The survey results highlight the significance of breed identification accuracy among respondents. Referring to Figure 3.17, this question utilized a Likert scale ranging from 1 (very unimportant) to 5 (very important). The mean score for this question is 4.0, which indicates that accuracy is essential to the respondents.

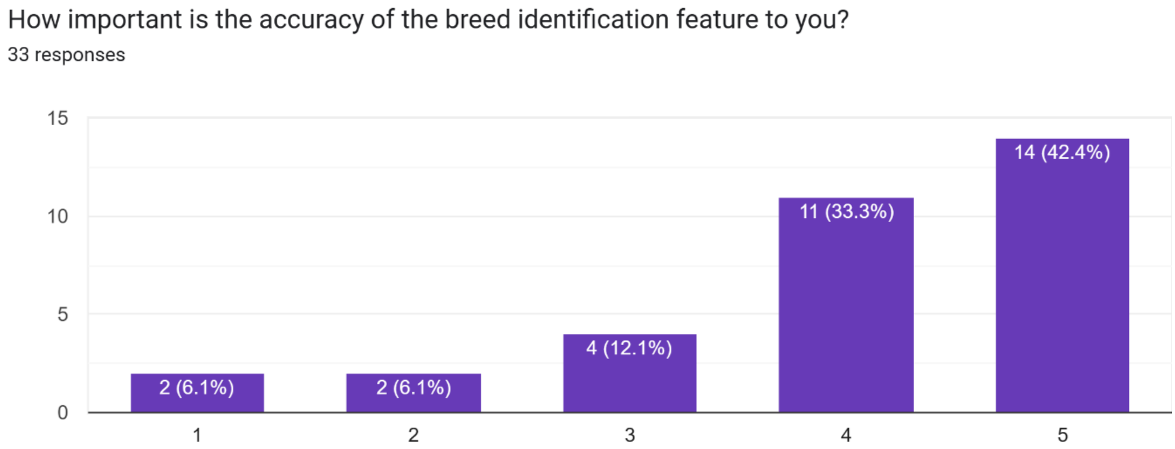


Figure 3.17: Bar Chart – Importance of breed identification accuracy

The next question is a single-choice question for the respondents' preferred interface design (refer to Figure 3.18). 42.4% (14) of respondents preferred fun and interactive designs featuring animations and icons. Meanwhile, 36.4% (12 respondents) preferred a simple, minimalist interface. 15.2% (5 respondents) chose a bright and colorful interface design. The remaining two respondents were selected for an informative design with detailed information and all of the above, respectively.

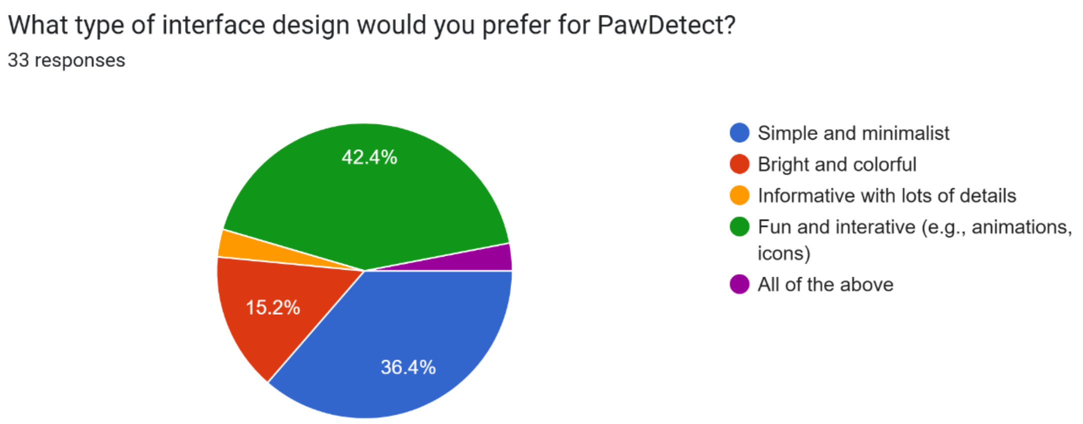


Figure 3.18: Pie Chart – Preferred interface design

The next question focused on respondents' preferred color theme for the proposed app (refer to Figure 3.19). The majority, 48.5% (16 respondents), preferred calm and soothing color palettes, like pastels, light blue, and soft green. Two groups tied with 24.2% (8 respondents), selecting either natural tones or minimalist and clean color palettes. Notably, only one respondent chose the minimalist and clean color theme.

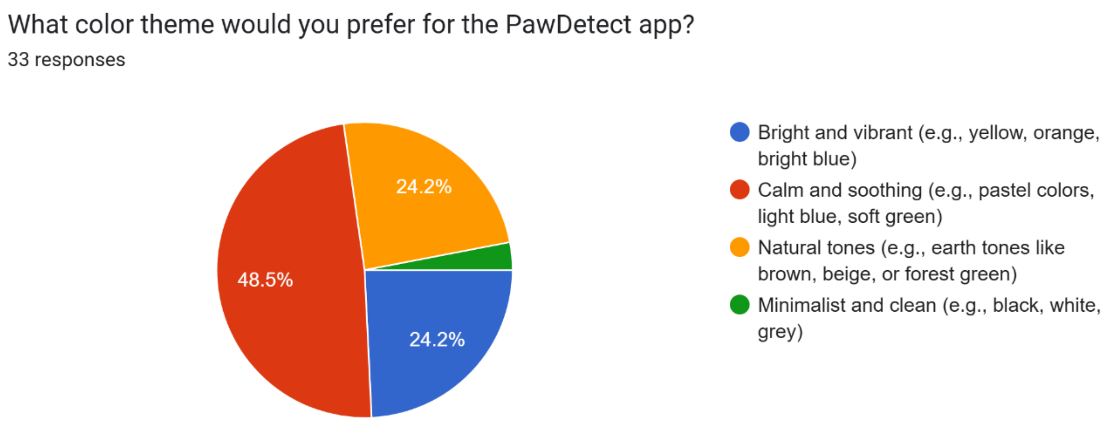


Figure 3.19: Pie chart – Preferred color theme

The last question of this section is the additional suggestions for the proposed app's features and design. The responses are shown in Table 3.2.

Responses	**Count**
No suggestions	19
Free app	1
Social events for pet dogs and furry child	1
Customizable	1
Simple and easy to navigate, idiot proof	5
Interactive navigation	1
More attractive	1
Cute puppy pattern	1
Detect the dog's emotions in real-time	1
Intelligent detection of biometrics of pets to register their profiles can cooperate with the government to make the pet's identity registration easier	1
Let the user input the vet appointments, medication reminders, vaccination schedules, and deworming dates, including notifications for due dates	1

Table 3.2: Additional suggestions on the app's features or design

3.2.4 Section 4: Overall Feedback

This section contains two questions: one single-answer question and an open-ended question. The first question asks whether respondents are willing to test the prototype of the proposed app (refer to Figure 3.20). 78.8% of respondents are willing to test the prototype, while the rest (21.2%) are not interested in testing it.

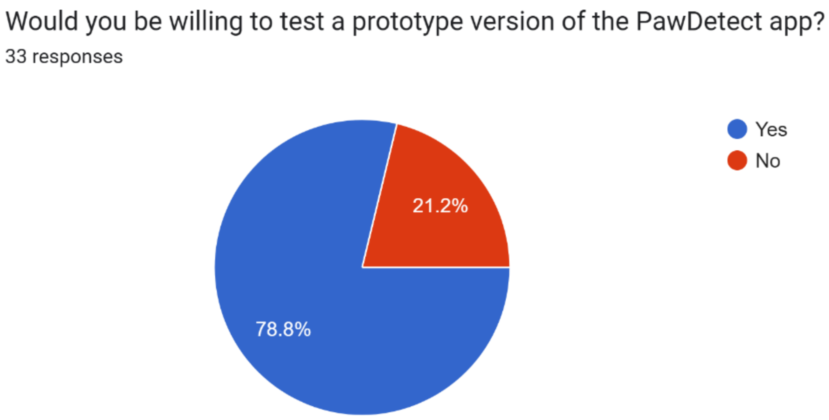


Figure 3.20: Pie Chart – Willingness of testing prototype

The final question is open-ended, inviting respondents to share any specific suggestions for the proposed app. Their responses are summarized in the table below.

Response	**Count**
No suggestion	29
Apply the concept Keep It Simple, Stupid	1
Make sure experts verify it	1
Use bright colors and minimalist UI	1
Give more tips for children on how to take care of their dogs	1

Table 3.3: Specific suggestions

3.3 Design

3.3.1 Use Case Diagram

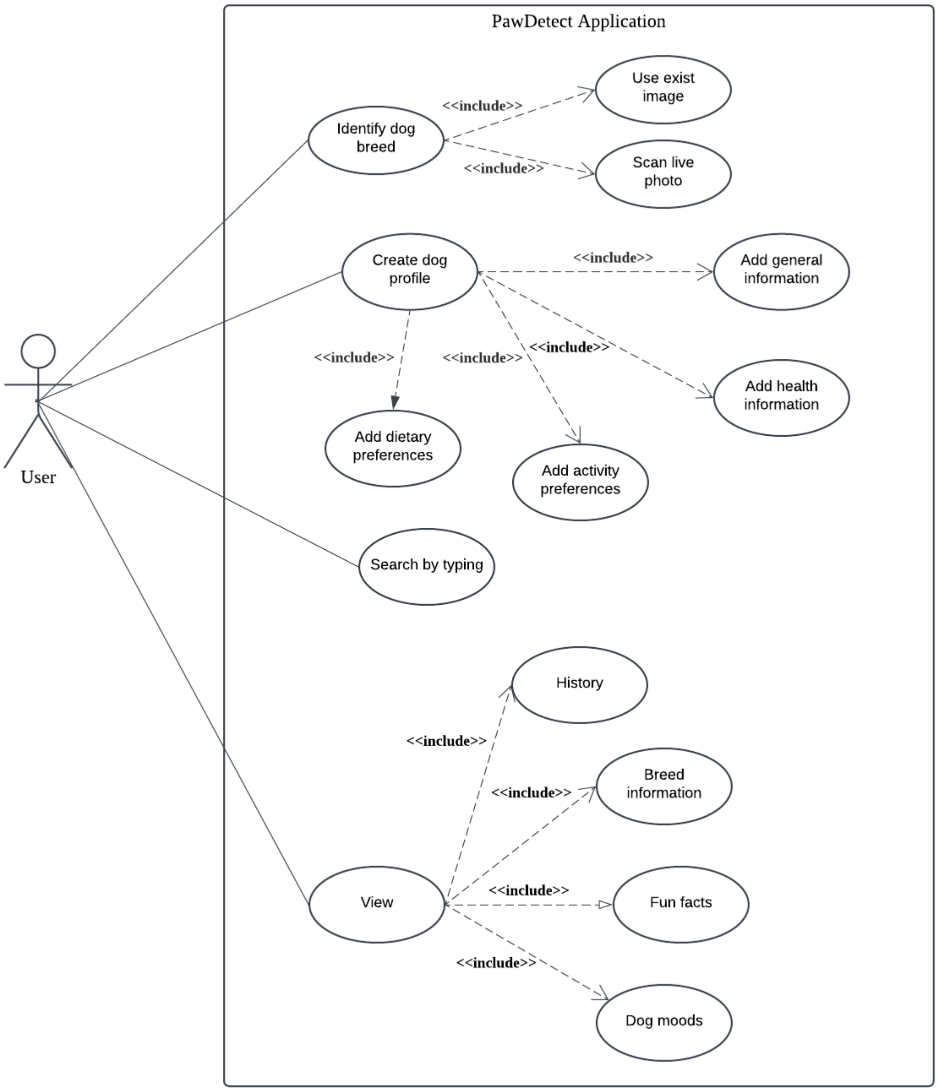


Diagram 3.1: Use Case Diagram

The proposed application has a single actor, the “User.” Users can identify the dog breed by uploading an existing image or capturing a live photo. Besides, users can create individual dog profiles for their pet dogs. Additionally, they can search for dog breeds, view the breed identification history, and access general and breed-specific information.

3.3.2 Application Sequence Diagram

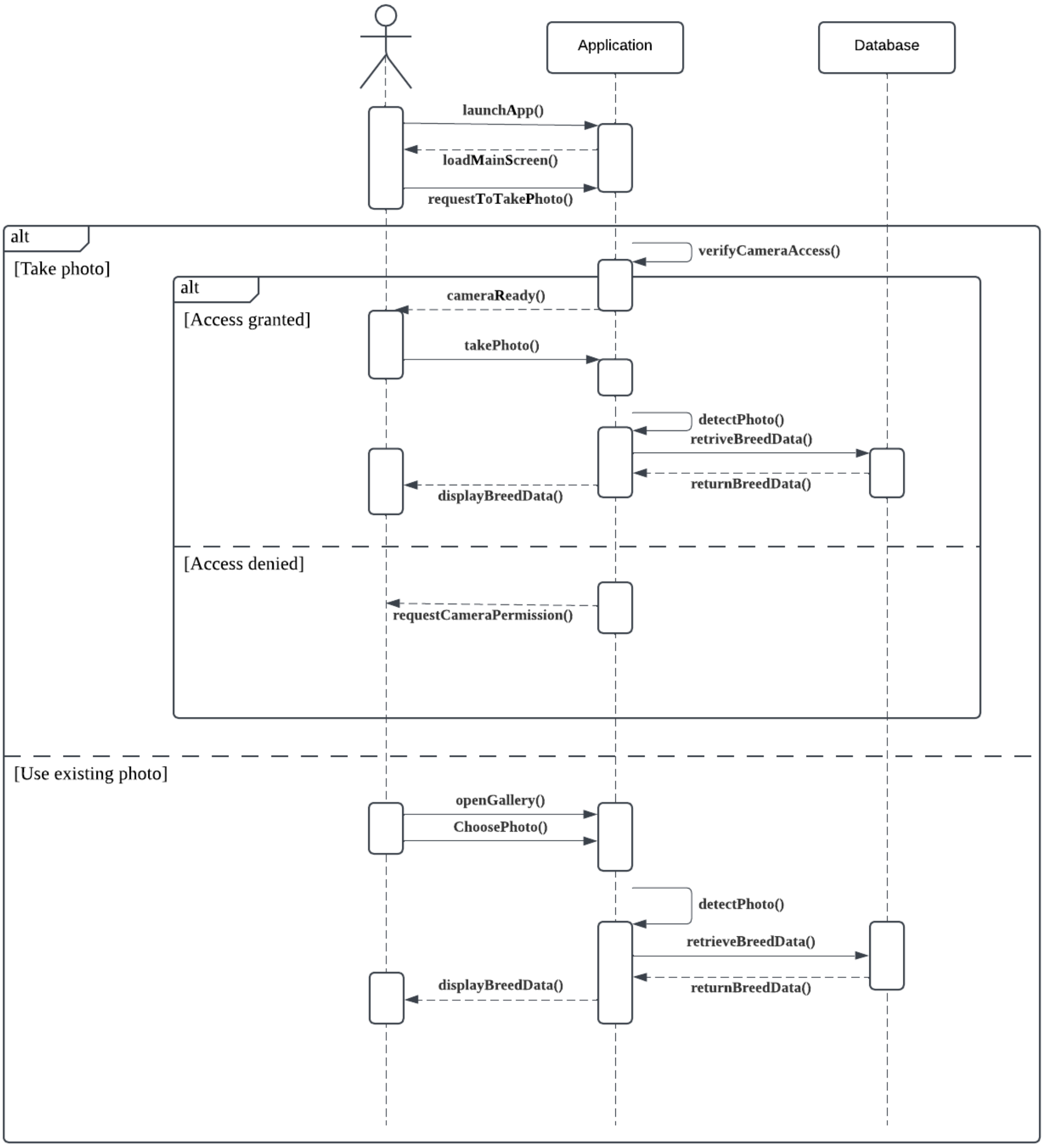


Diagram 3.2: Identify Dog Breed Diagram

The sequence diagram above illustrates the interaction between the user, application, and database during the dog breed identification in the proposed application. It highlights two flows to identify a breed: via camera and the device's gallery.

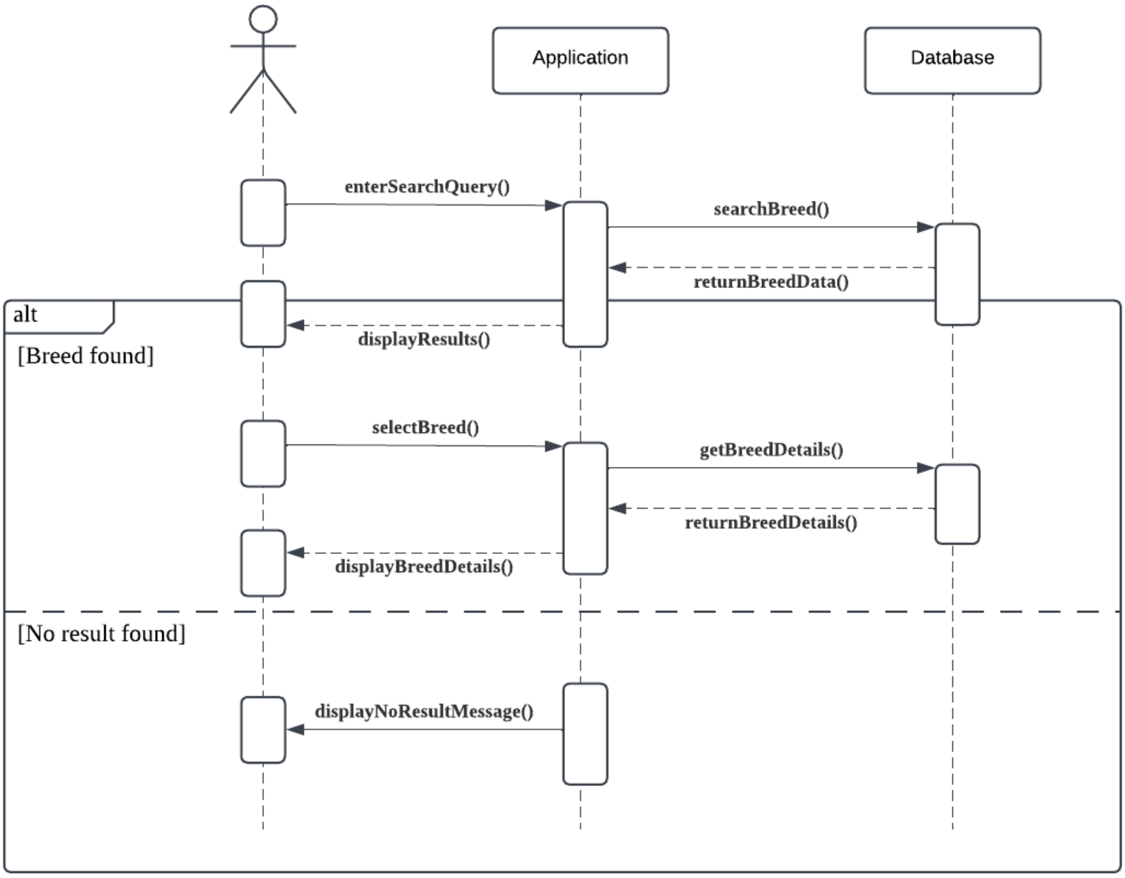


Diagram 3.3: Search Dog Breed Diagram

Diagram 3.3 depicts the user-database interaction in searching for dog breeds within the proposed application. The diagram shows the following flow: users enter the dog breed's name, and the application queries the database for matching breed entries and shows the results.

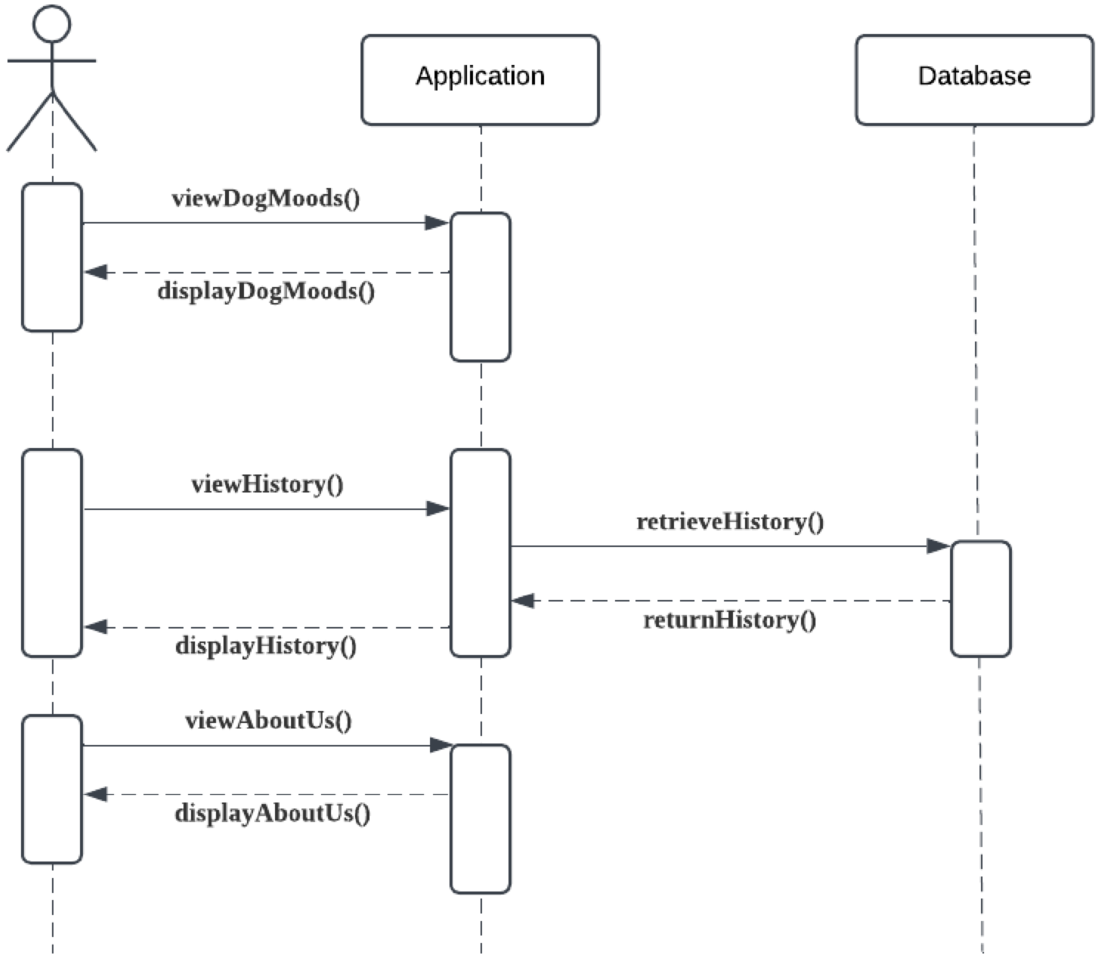


Diagram 3.4: Settings Page Diagram

Diagram 3.4 illustrates the user interaction flow within the settings page of the proposed application. The user can access the general dog mood information, the identification history, and the app's information.

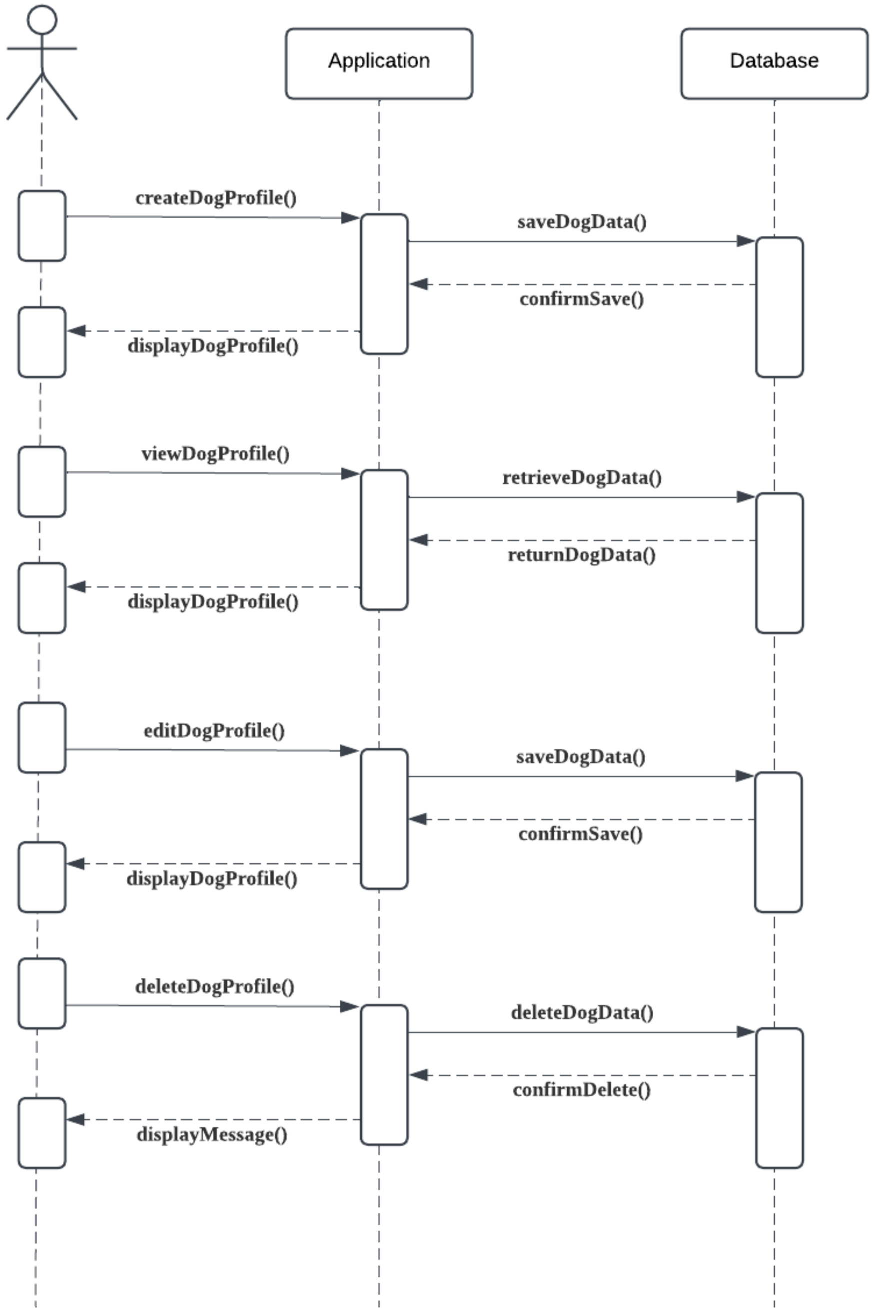


Diagram 3.5: Create Dog Profile Diagram

The diagram above outlines the interaction between the user and the dog profile page of the application. Users can create, edit, view, and delete the pet dog profile.

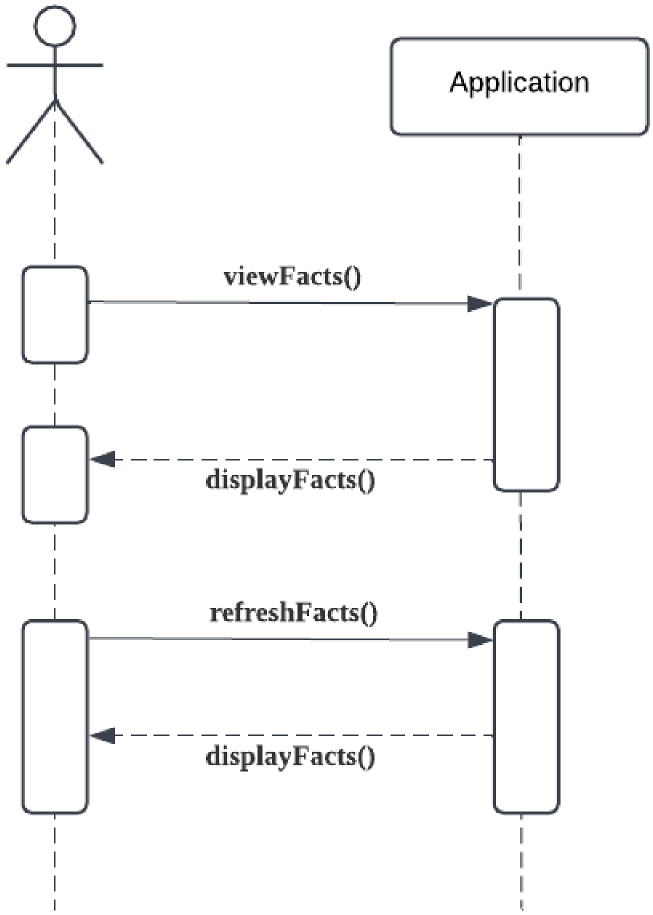


Diagram 3.6: View Facts Diagram

Diagram 3.6 outlines the workflow of the facts page within the application, allowing users to view and refresh the dog facts.

3.3.3 Application Flowchart

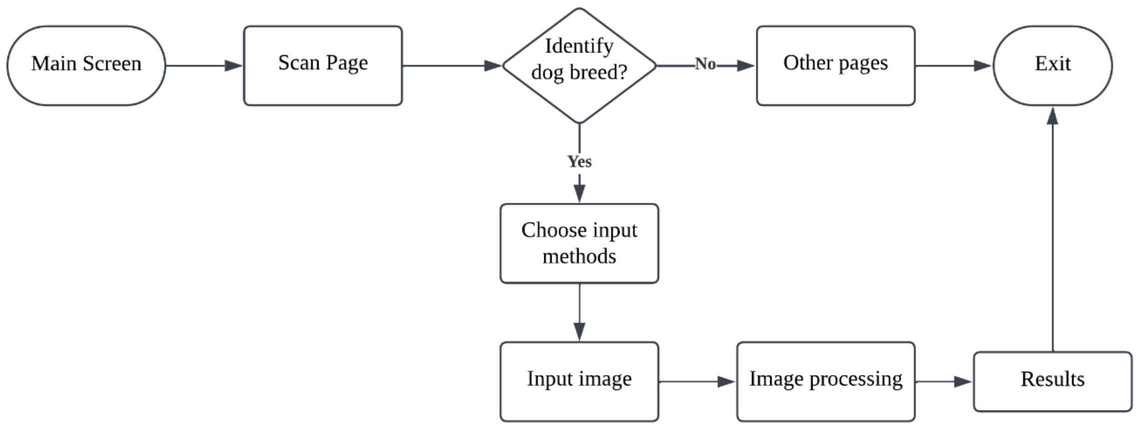


Diagram 3.7: Breed Identification Flowchart

The flowchart illustrates the core functionality of the proposed application, which is dog breed identification. From the main screen, the user navigates to the scan page. If the user wants to identify a dog breed, they must select how to input an image and proceed with image processing. The application will display the identified breed along with the relevant information. Alternatively, users can choose other options from the scan page, such as adjusting settings, searching, viewing dog facts, managing dog profiles, or exiting the application.

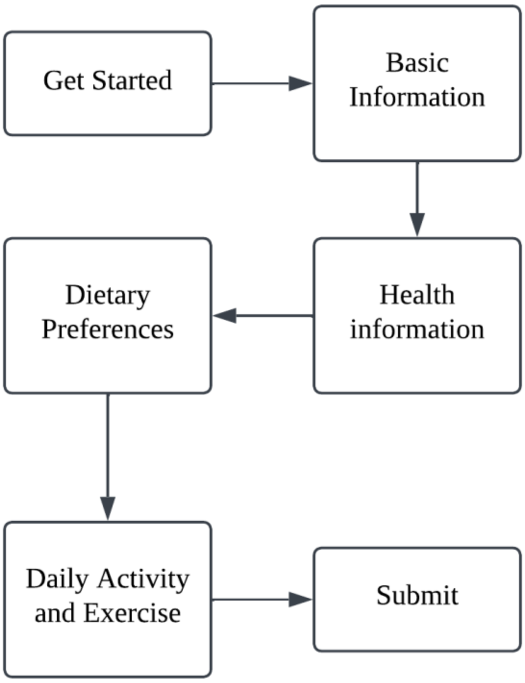


Diagram 3.8: Pet Dog Profile Setup Flowchart

The flowchart above describes the proposed application's pet dog profile setup process. First, the user provided basic information like the dog's name and breed. Following this, the user enters health information, such as allergies the dog may have. Once continued, the user can proceed to the dietary preferences page. User can specify their dog's nutritional needs and restrictions. After entering dietary information, the user indicates the dog's activity levels, such as exercise frequency. Finally, the personalized pet profile is saved once the user submits the information.

3.3.4 Activity Diagram

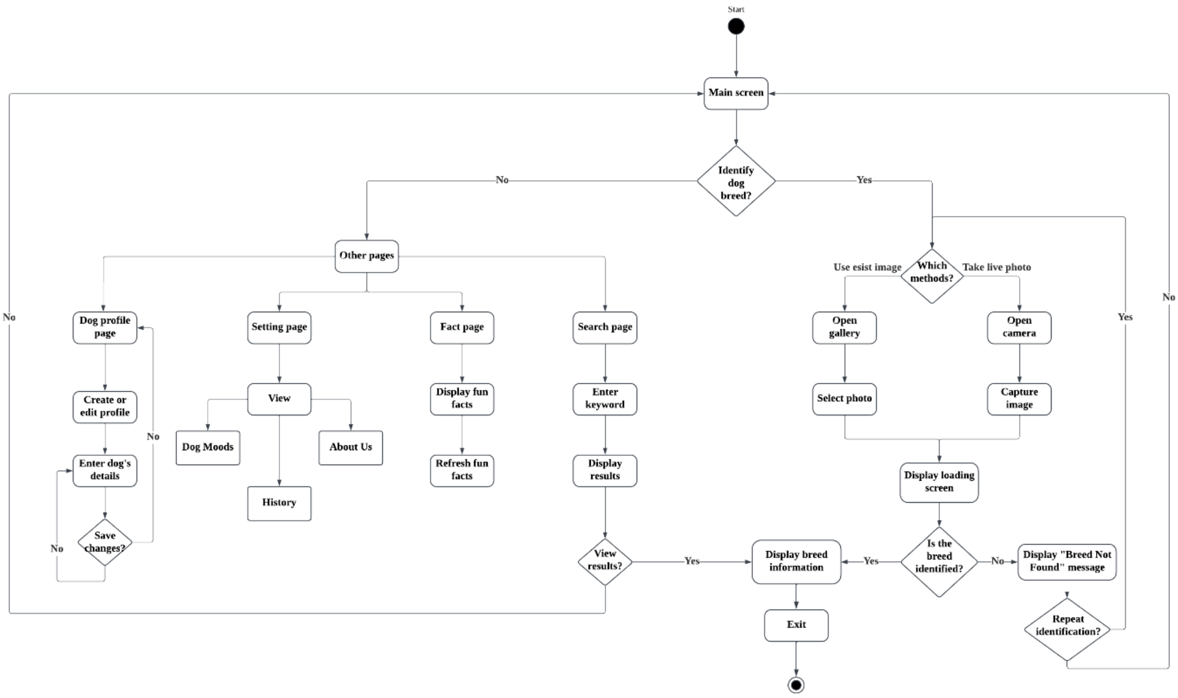


Diagram 3.9: Activity Diagram

The activity diagram presents the workflow of the PawDetect application. The app starts on the main screen, and users have two options: begin immediate breed identification or explore other pages. Users can upload an image by taking a live photo or selecting an existing image from their device. Once the image is uploaded, the loading screen is displayed when the image is processed. From the main screen, users can navigate to the following pages: dog profile, search, facts, and settings. The dog profile page can create and manage individual dog profiles. The search page allows users to search for dog breeds manually. The facts page displays a collection of fun facts about dogs with a refresh option. Another page is the settings page. Users can view the general dog mood knowledge, the breed identification history, or the information about the app.

3.3.5 Class Diagram

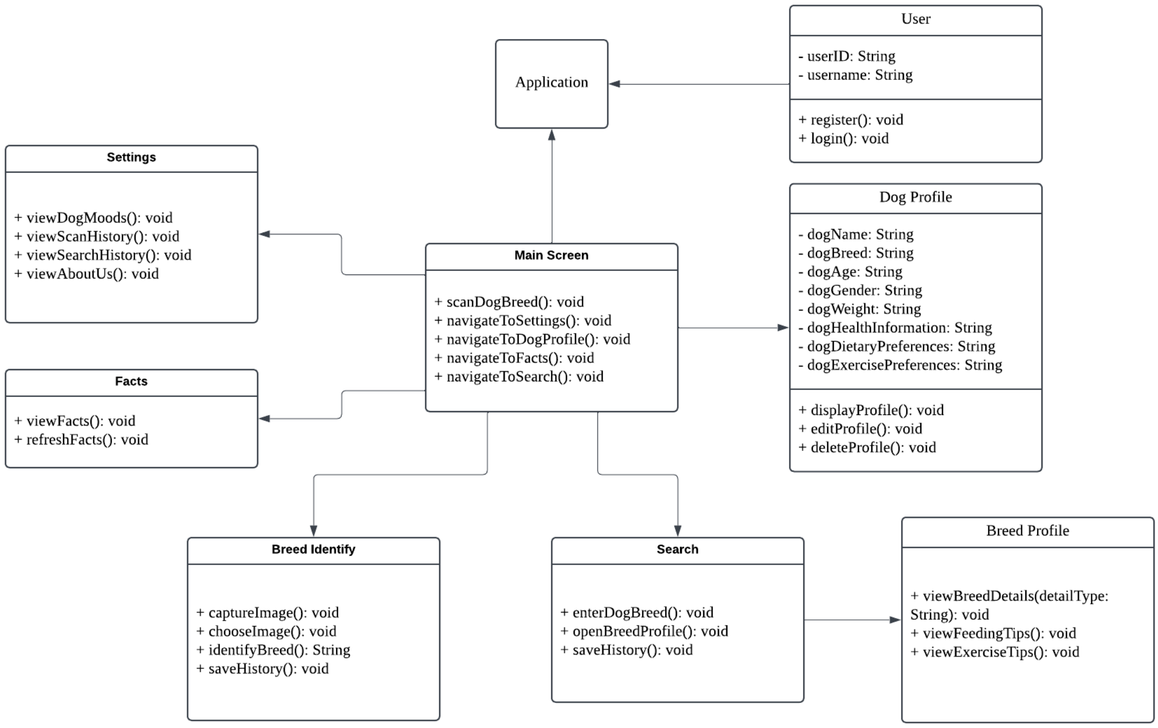


Diagram 3.10: Class Diagram

The class diagram illustrates the object-oriented structure of the PawDetect application. The application class acts as the application's core, managing the interactions between the user and the main screen. The user class represents users with the attributes for identifying users and the user registration and login methods. The main screen class provides methods to navigate the app's features, such as dog breed scanning, breed searching, viewing settings, exploring facts, and managing pet dog profiles.

3.4 User Interface Design

Figure 3.21 shows the interface design of the main screen of the PawDetect app, which includes the logo and the application name.

Figure 3.21: Mockup – Main screen

Figure 3.22 outlines the workflow of the breed identification. First, users will see two options on the scan page: take a photo or open the gallery. The application then requests permission to access the device's camera or gallery. After uploading the image, the application processes it, and the result and the breed's profile are displayed. Users can click on the breed profile for detailed information, including characteristics and specific training and exercise tips.

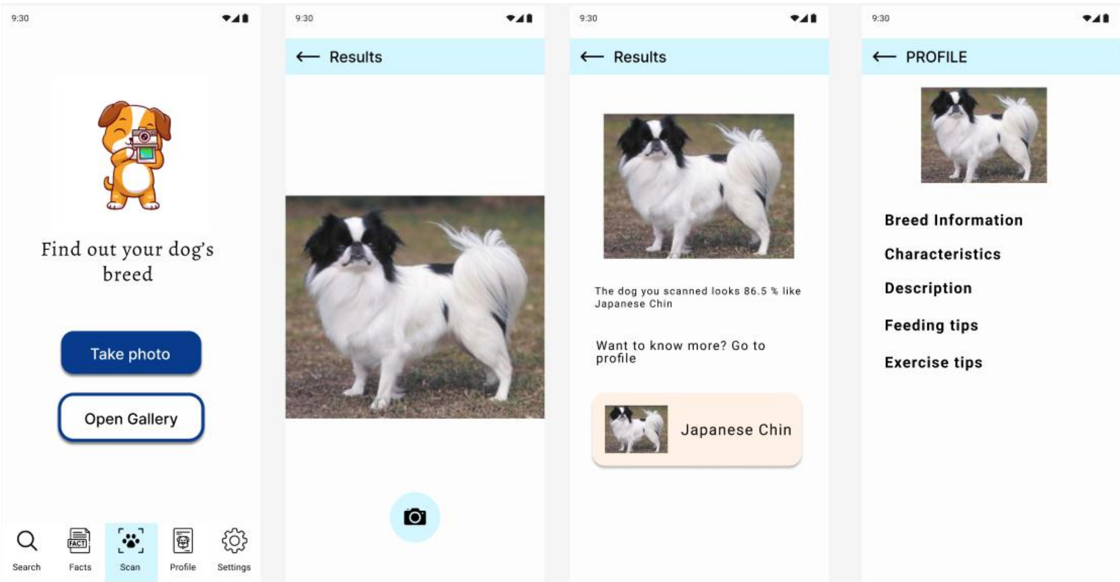


Figure 3.22: Mockup - Breed identification by taking a live photo or choosing a picture from the gallery

Figure 3.23 depicts the design of PawDetect's search page, which enables users to search for dog breeds manually.

Figure 3.23: Mockup – Search dog breed

Figure 3.24 shows the breed profile, which includes the breed information, characteristics, description, feeding tips, and exercise tips.

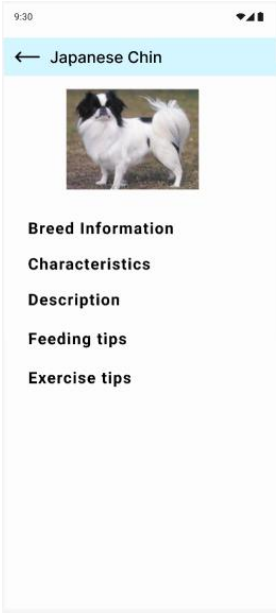


Figure 3.24: Mockup – Breed profile

Figure 3.25 showcases the design of the dog profile page, where users can create individual profiles for each of their pet dogs.

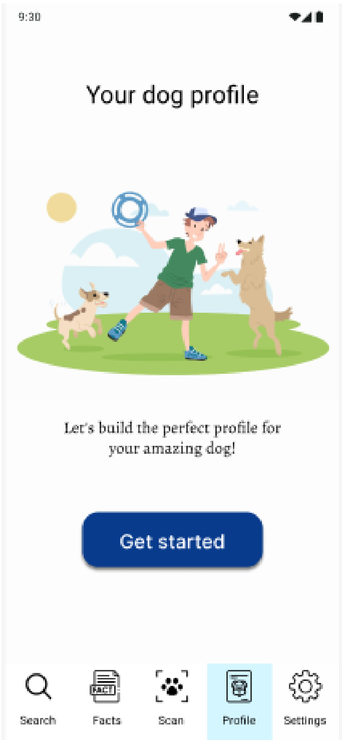


Figure 3.25: Mockup – Create the user's dog profile

Figure 3.26 outlines the four key components that comprise a dog's profile: basic information, health information, dietary preferences, and daily activities and exercises.

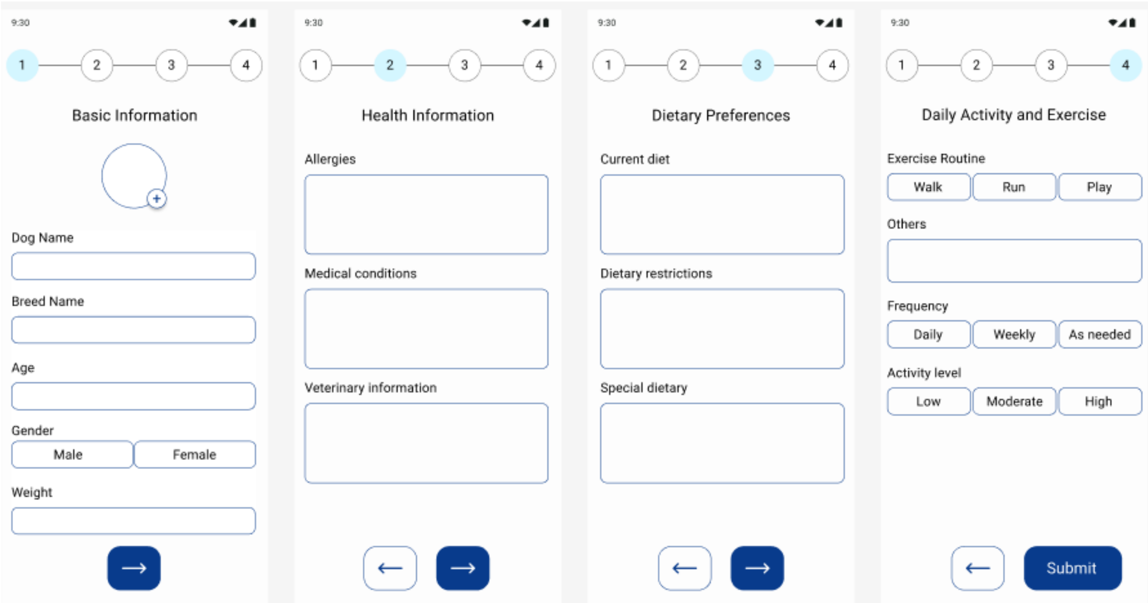


Figure 3.26: Mockup – Information needed to create a dog profile

Figure 3.27 displays the completed dog profile page, allowing users to edit, view, or delete the profile information through the menu button at the top right corner.

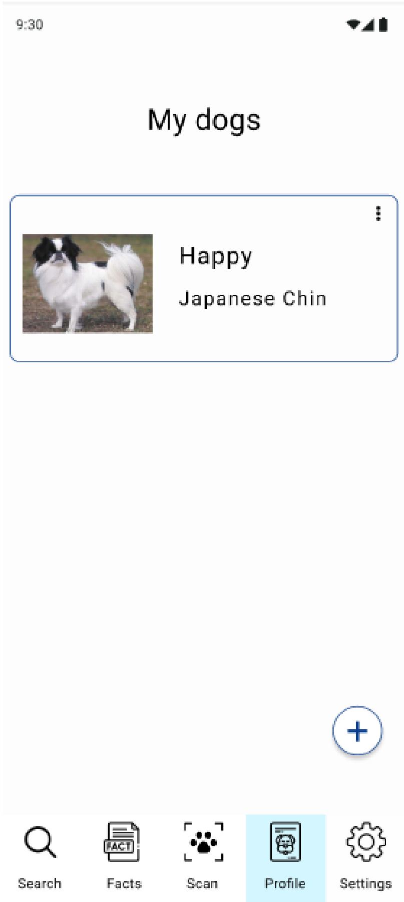


Figure 3.27: Mockup – Profile page after creation

Figure 3.28 presents the facts page, enabling users to refresh and display new dog-related facts.

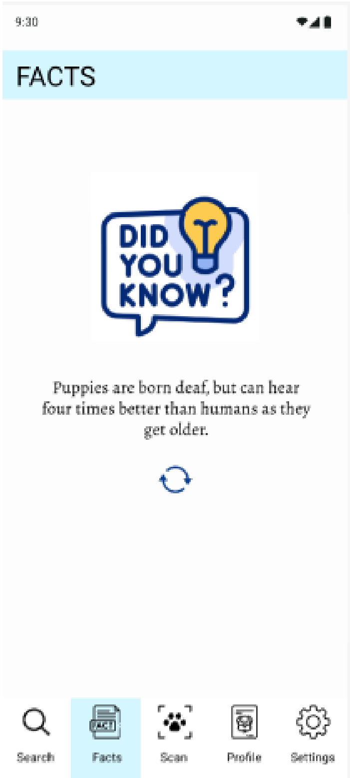


Figure 3.28: Mockup – Facts page

Figure 3.29 depicts the settings page and the related pages: history, dog moods, and about us.

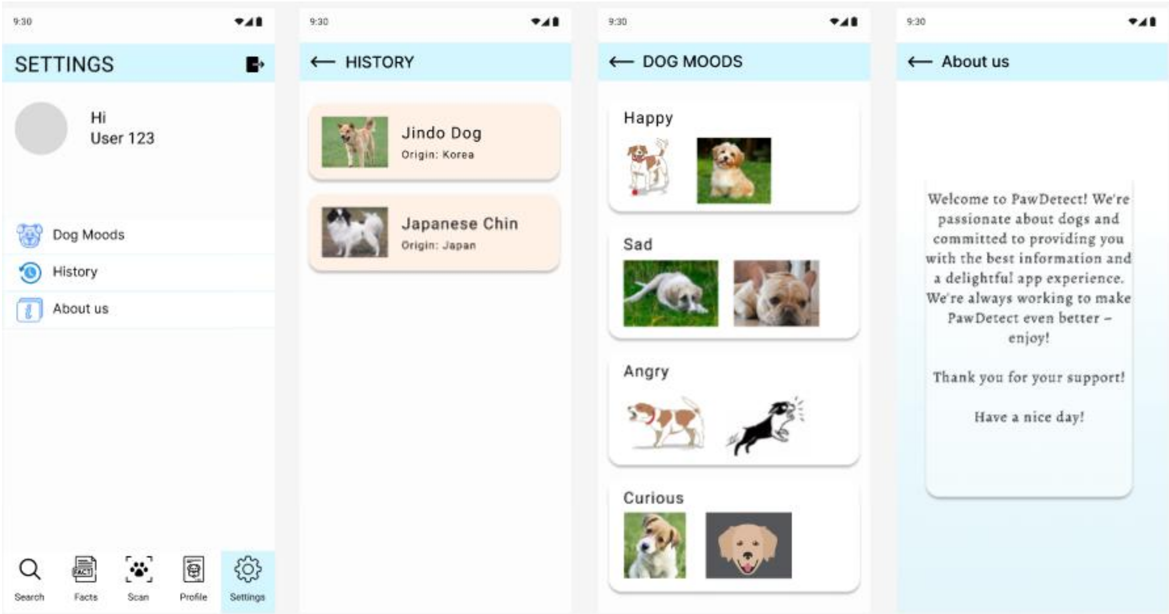


Figure 3.29: Mockup – Settings page and the related pages

3.5 Summary

This chapter highlights the user requirements gathered through a Google form questionnaire collected from 33 respondents. It analyses the demographics, user experience with existing apps, and expectations for proposed PawDetect’s features and designs. This chapter also presents the diagrams, including use case, sequence, flowchart, activity, and class diagram. These diagrams outline the proposed application’s structure and functionality. The last part of this chapter is the user interface design. It showcased the mockups for the main functions of the proposed PawDetect app, including breed scanning, search functions, pet dog profile creation, settings, and educational content.

CHAPTER 4 : DEVELOPMENT AND IMPLEMENTATION

4.1 Introduction

This chapter will discuss the application implementation based on the design in Chapter 3. The tools and software described in the previous chapter are used to develop the proposed dog breed identification app. The following sections provide the details of the feature and the user interface for the proposed PawDetect application.

4.2 Data Validation and Model Training

4.2.1 Dataset and Splitting

This dataset includes 20 dog breeds, which are Afghan Hound, Akita, Basenji, Bichon Frise, Border Collie, Chinese Shar-Pei, Chow Chow, Dalmatian, Golden Retriever, Japanese Chin, Lhasa Apso, Pekingese, Pembroke Welsh Corgi, Pomeranian, Pug, Samoyed, Siberian Husky, Standard Schnauzer, Thai Ridgeback, and Tibetan Mastiff.

Dataset Split	Number of Images
Training	35
Validate	10
Test	5
Total	**50**

Table 4.1: Image Dataset Distribution (Images per Breed)

A single model is trained to classify all 20 breeds; each breed includes 50 images, and the total is 1000. The 50 images are split into 70% (35 images) for training, 20% (10 images) for validating, and 10% (5 images) for testing. The majority of the photos are sourced from the

Stanford Dog Dataset (*Stanford Dogs Dataset for Fine-Grained Visual Categorization*, n.d.), with a few additional images from the AtharvaTaras Dataset (AtharvaTaras, n.d.) to enhance better representation and diversity.

4.2.2 Model Training

Google Teachable Machine, a web-based image classification tool, is used to train machine learning models (Teachable Machine, n.d.). First, 20 classes are created, each labeled with the breed's name. For each class, 45 images are uploaded. After uploading all the images, the training process is initiated. The number of epochs is adjusted to improve the model's classification performance and ensure accurate breed detection. Once the training is complete, the model is exported to TensorFlow Lite (.tflite) format. This model is then integrated into the PawDetect app to enable the on-device dog breed classification.

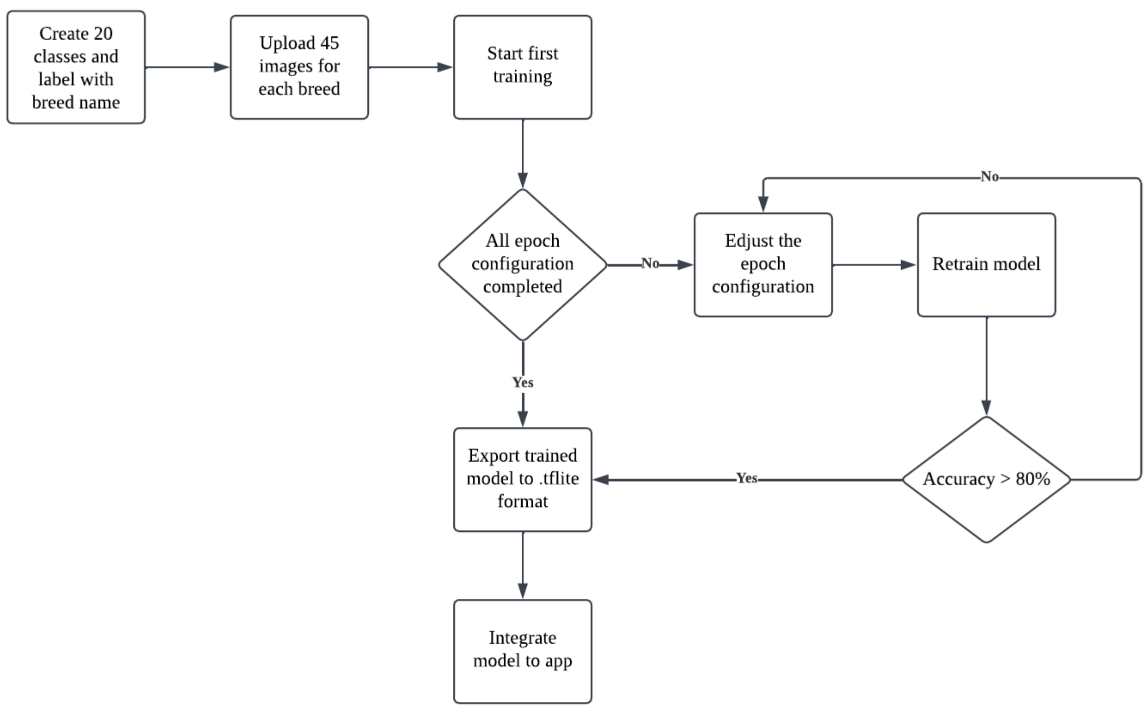


Diagram 4.1: Model Training Flowchart

4.3 Important Process and Pseudo-code

4.3.1 Image Acquisition and Storage

The PawDetect's core function is dog breed identification. To begin the process, the user selects the input methods by taking a live photo or choosing an existing photo from the device's gallery. Once the image is obtained, it and its URI are temporarily stored in a shared ViewModel named ScanResultViewModel. This method can ensure smooth data handling between two fragments, from the image input page to the scan result page.

Once the image URI is stored, the app navigates to the scan result page, where the image undergoes preprocessing and is passed to the machine learning model for classification. The pseudo-code representing the image acquisition and storage process is shown below.

```
IF choose "Take Photo" THEN
     Open the camera
     Capture an image
      Navigate to the scan result page
ELSE
     choose "Open Gallery"
     Open the gallery
     Choose an image
      Navigate to the scan result page
END IF
```

Figure 4.1 Pseudo-code for Image Acquisition and Storage

4.3.2 Image Preprocessing

Before the model classifies the image, it undergoes preprocessing to ensure it is compatible with the TensorFlow Lite model and to improve prediction accuracy. In PawDetect, the preprocessing steps are handled by the model framework, primarily since the model was exported from Teachable Machine, which standardizes the expected input format.

The main preprocessing steps include resizing, normalization, and bitmap conversion. First, the image is resized to the dimensions required by the model, which is 224 x 224 pixels. This is to ensure consistency across all inputs. Next is normalization. Pixel values are scaled from the original 0 to 225 range to between 0 and 1. This normalization helps the model interpret image data more effectively. The image is then converted to a Bitmap format and then to a ByteBuffer structure that is required for TensorFlow Lite inference.

These steps are performed in the background when the image is passed to the model for prediction. By standardizing the image size and scale, preprocessing ensures that the model receives clean and consistent input. This can reduce the risk of misclassification due to image variability, such as brightness or image resolution. The pseudo-code of the image preprocessing process is shown below.

```
IF the image is successfully loaded THEN
    Resize the image to 224 x 224 pixels
    Create a byte buffer to store pixel data

    FOR each row from 0 to 223
        FOR each column from 0 to 223
            Get the pixels at the current position
            Extract RGB color values
            Normalize each color value

            IF RGB values >= 0 THEN
                Add RGB to byte buffer as float numbers
            END IF
        END FOR
    END FOR
    Return byte buffer
ELSE
    Return null since image cannot be loaded
END IF
```

Figure 4.2 Pseudo-code for Image Preprocessing

4.3.3 Image Classification and Result Storage

Once the image is preprocessed, the app uses the TensorFlow Lite model to identify the dog breed. The model was exported in a lightweight format suitable for mobile applications.

The classification begins when the preprocessed image is converted into a ByteBuffer format. The model then processes the image and returns a list of prediction results. Each result includes a breed label and a confidence percentage. The predictions are sorted in descending order of confidence, and the top three results are shown to the user on the result page.

This classification process runs effectively on the testing device and typically takes only a few seconds. If the model's top confidence score is less than 60%, the app classifies the image as "Unknown Breed." This indicates that the dog might not belong to one of the 20 breeds trained categories.

In addition to displaying results, key scan data, the timestamp, predicted breed name and confidence percentage are uploaded to the Firebase Realtime Database. These data are organized well under a parent node named "scans" and further structured by each authenticated user's unique ID and the timestamp as the reference to find this history. This hierarchical structure ensures each user's scan history is logically separated and prevents the potential for data mix-up between users.

The pseudo-code of the dog breed classification and result storage process is shown below.

```
BEGIN
    Get preprocessed image
    Convert image into byte buffer format
    Run the model
    Sort the prediction results in descending order
    Show top 3 results
    IF  confidence < 60% THEN
        Display “Unknown Breed” to the user
        Set predicted breed as “Unknown Breed”
        Record the confidence of top prediction
    ELSE
        Display top 3 predicted breeds
        Set the first predicted breed as the label of
        prediction
        Record the confidence of top prediction
    END IF
    Get the current date and time
    Get the ID of user
    Save the predicted breed, confidence score and
timestamp to database
END
```

Figure 4.3 Pseudo-code for Image Classification and Result Storage

4.3.4 Dog Profile Management

The PawDetect app allows users to create and manage profiles for their pet dogs. Once the user completes all four profile steps: basic information, health information, dietary preferences, and daily activities, the data is stored securely in the Firebase Realtime Database. These profiles are saved using a structured and user-specific format to ensure privacy, proper organization, and accurate retrieval.

The data is stored under a main node named “DogProfiles” when the user submits a new dog profile through the app. Firebase Authentication assigns each authenticated user a unique User ID (UID). The user’s dog profiles are grouped under this UID to ensure personal data isolation and prevent cross-access between users.

For each pet dog added by the user, the Firebase generated a unique dog ID. This prevents confusion when multiple profiles exist and ensures that each dog’s data is uniquely identifiable and modifiable. Under each dog ID, the dog profile is divided into four parts: basic information, health information, dietary preferences, and daily activities to save comprehensive details about the pet. If the user is editing an existing profile, the existing dog ID is used to overwrite the profile. The pseudo-code of the dog profile management is shown below.

```
BEGIN
    Get current user ID from Firebase Authentication
    Create a new dog profile by filling the four forms
    IF the view model is in edit mode AND dog ID exists THEN
        Update existing profile in the database
        IF the profile is successfully updated THEN
            Display the message “Profile updated
            successfully”
            Navigate to the new profile screen
        ELSE
            Display the message “Failed to update profile”
        END IF
    ELSE Generate a new dog ID
        IF a new dog ID is successfully generated THEN
            Save the new dog profile to Firebase under the
            ID generated
            IF successfully saved the profile THEN
                Display the message “Profile created
                successfully”
                Navigate to the new profile screen
            ELSE
                Display the message “Failed to create
                profile”
            END IF
    END IF
```

Figure 4.4 Pseudo-code for Dog Profile Management

4.3.5 Dog Breed Data Fetching

To provide detailed dog-related information, the PawDetect app incorporates external and internal data sources to enrich the breed identification experience. The process begins after a user scans or selects a dog breed. Once a breed is identified, the app navigates to a detailed breed profile page. This page displays general and specific breed data by fetching the information from an external API and Firebase Firestore. The general breed information, such as temperament, origin, and breed group, is retrieved from an integrated external API, while the specific information, like exercise needs and health, is stored and retrieved from Firebase Firestore.

The app uses the breed name as a key to fetch related data from two resources. The app sends a network request to the API, while the API returns the general information. In addition to general details, the app queries a custom collection in Firestore, where the developer stores specific breed-related details manually.

Once API and Firestore responses are received, the app parses and merges the data. The combined information is presented in a detail fragment, including the breed image and general and specific details. The pseudo-code of the dog breed data fetching is shown below.

```
BEGIN
    Get selected breed data
    Extract breed name
    Connect to Firestore database
    Retrieve document from database
    IF document exists THEN
        Display general information
        Display specific information
    ELSE
        Display general information

        Display “Not Found” for specific information

    END IF
```

Figure 4.5 Pseudo-code for Dog Breed Data Fetching

4.4 App Design

The app design phase focuses on the visual layout, user interaction, and navigation structure of the proposed dog breed identification application, PawDetect.

4.4.1 Color theme

The PawDetect application adopts a clean and modern color theme to reflect warmth and friendliness, aligning with the pet care and education-focused app. A light cream tone is used for the general background to reduce eye strain. A deep blue is used for action buttons, while a lighter blue is used for highlights and selected states. A dark slate color is used for primary text to ensure readability.

4.4.2 Typography and Icons

Combining two sans-serif fonts was selected to create a clean and aesthetically pleasing user interface. Poppins are used for all titles, headers, and important highlighted phrases. This font grabs the attention of users and creates a strong visual hierarchy. Raleway is used for body content, descriptions, and labels. It is elegant and readable on the mobile screens.

Icons are used in the app to enhance usability and reduce the reliance on text labels. Each tab in the bottom navigation menu features a representative icon. Additional icons are used for user actions like navigating to a specific page, returning to the previous page, or expanding or collapsing content.

4.4.3 Layout and UI Components

Each screen in the app follows a structured layout to promote familiarity and ease of use. The UI components used in the app include the bottom navigation bar, card view, expandable layout, and buttons. Spacing and padding are used consistently to create a breathable and non-cluttered interface.

4.4.4 Navigation Flow

The proposed PawDetect app used a fragment-based navigation structure to support the seamless user experience. The main page of this app is the scan fragment. From the bottom navigation bar, users can directly navigate to other fragments: search fragment, fact fragment, dog profile fragment, and the settings fragment.

4.5 The Proposed Mobile Application

In this section, we provided the screenshot of the proposed PawDetect application.

4.5.1 Splash Screen

Figure 4.6: Splash Screen

When users open the app, they see the splash screen, as shown in Figure 4.6, before proceeding to the main interface.

4.5.2 Scan Page

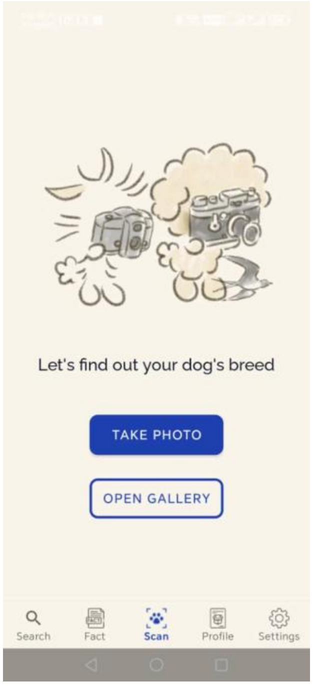


Figure 4.7: Scan Page

When users enter the app, they are taken to the Scan page, as shown in Figure 4.7. Users can start identifying a dog breed on this page by tapping the 'TAKE PHOTO' button to capture a new image or the 'OPEN GALLERY' button to select an existing photo.

4.5.3 Scan Result Page

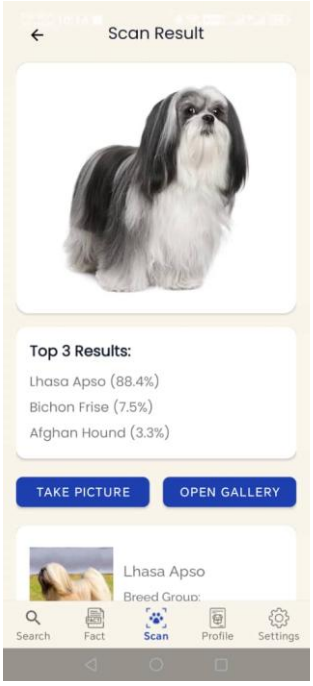


Figure 4.8: Scan Result Page

After users take or select a photo for identification, the result is displayed on the page shown in Figure 4.8. This page presents the input image, the top three predicted dog breeds, and their corresponding confidence levels. Users can retake a photo or select a new one using the 'TAKE PHOTO' or 'OPEN GALLERY' buttons. Below these buttons, the profile card of the breed with the highest confidence is shown. Users can tap on the breed card to view detailed information about the selected breed.

4.5.4 Dog Profile Page

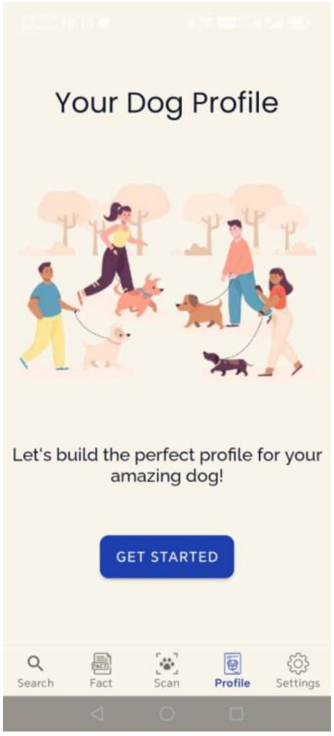
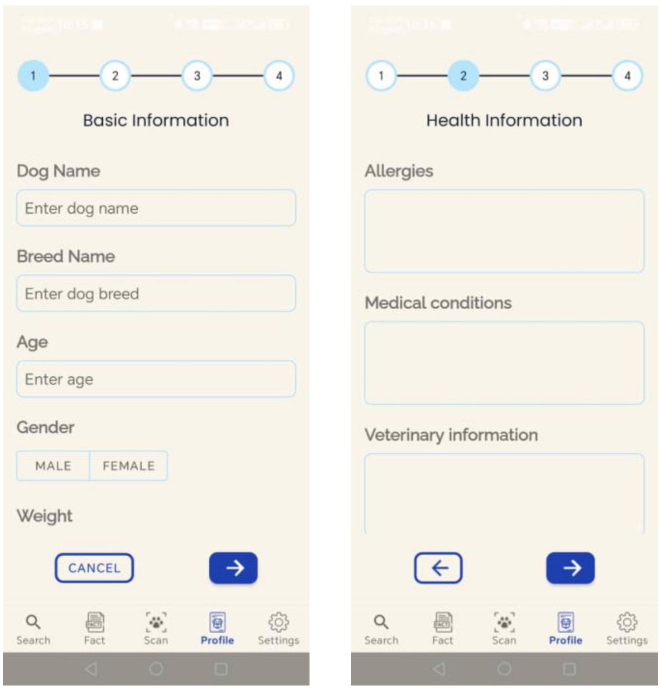


Figure 4.9: Dog Profile Page



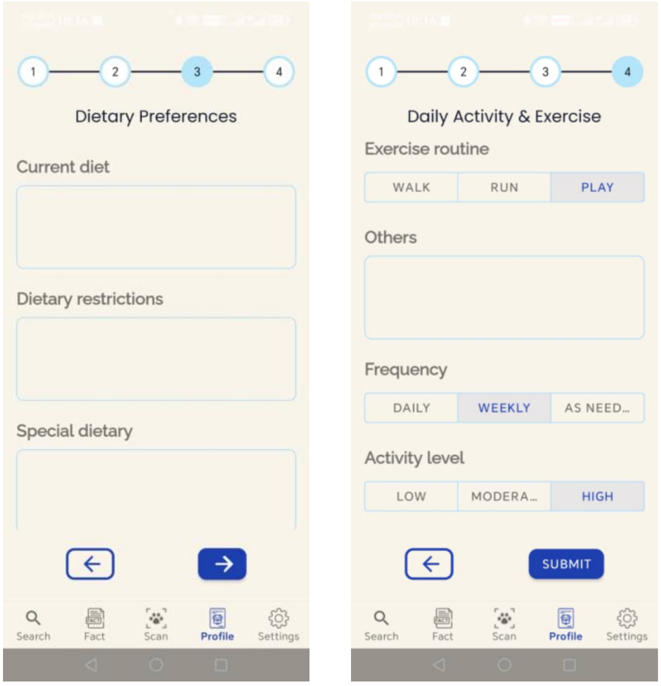


Figure 4.10: Information pages to create a dog profile

Figure 4.9 shows the default Dog Profile page. Users can begin creating a profile for their pet dog by clicking the 'GET STARTED' button. This action takes them through a series of forms, as illustrated in Figure 4.10. The first form page collects basic information and includes a 'CANCEL' button, allowing users to exit the profile creation process if desired. If users choose to proceed, they continue through subsequent pages covering health information, dietary preferences, and daily activity and exercise. Users can navigate back to the previous section on each page to review or edit information. On the final page, Daily Activity and Exercise, users must confirm and submit all the information they have entered to complete the profile creation process.

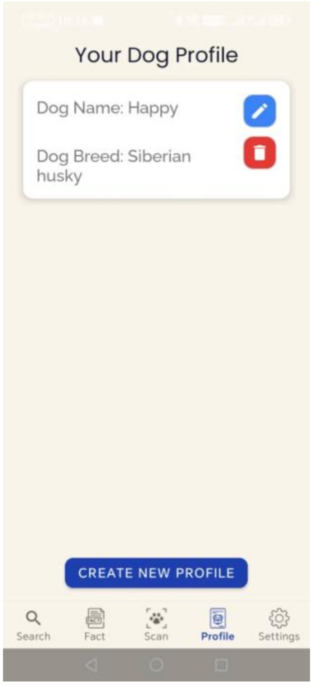


Figure 4.11: New Dog Profile Page after creation

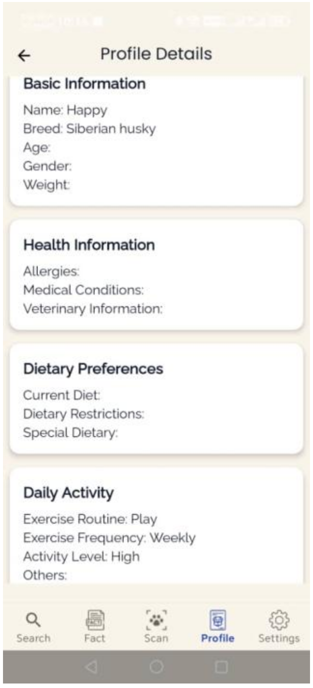


Figure 4.12: Profile Detail Page

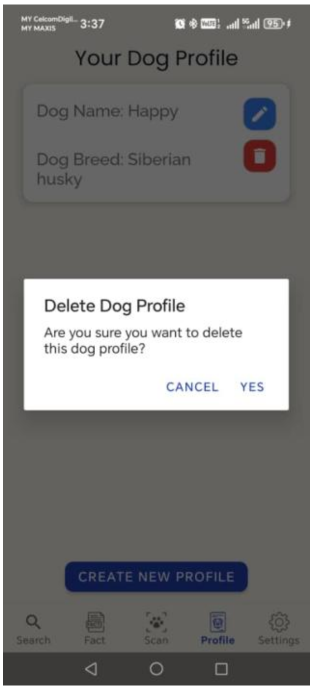


Figure 4.13: Confirm deletion message

After users submit the form, they are directed to Figure 4.11, the new dog profile page. This page displays the card representing the newly created pet dog profile. The user can see the pet dog's card and view the profile details by tapping the card. Figure 4.12 shows the pet dog profile details, and users can return to the main profile page by clicking the back icon at the top left corner. Users can create another pet dog profile on the profile page by the “CREATE NEW PROFILE” button.

Additionally, users can choose to edit or delete an existing profile. The edit option redirects them to the form shown in Figure 4.13, pre-filled with the pet dog’s existing information. A confirmation dialog appears if users want to delete a profile, as shown in Figure 47. Users may proceed with the deletion by selecting “YES” or cancel the action by selecting “CANCEL”.

4.5.5 Search Page

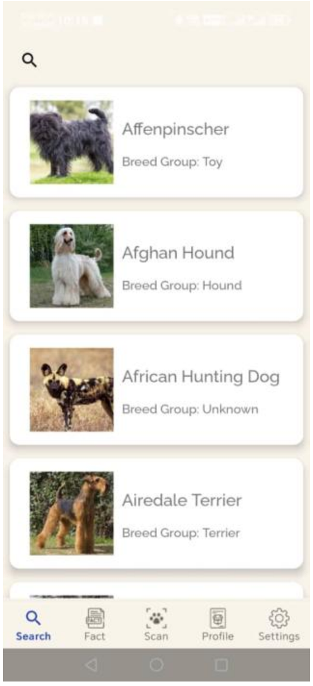


Figure 4.14: Search Page

Figure 4.14 illustrates the Search page of the PawDetect app. This page displays a list of dog breeds. Users can enter the breed name of the dog they prefer at the search bar to find the breed quickly. Users can click on the breed card to view the breed details.

4.5.6 Breed Detail Page

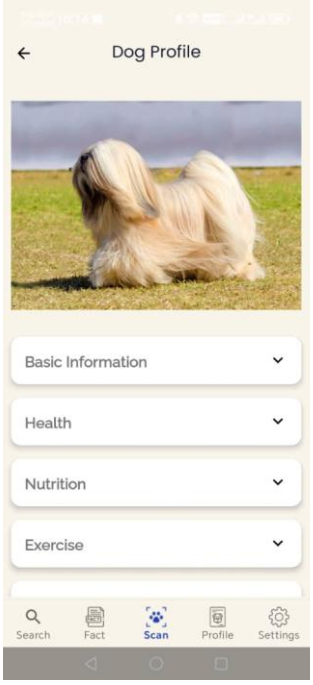


Figure 4.15: Breed Detail Page

Figure 4.15 is the breed detail page. Users can expand each card to view detailed information or collapse the card to hide the content for a cleaner view.

4.5.7 Fact Page

Figure 4.16: Fact Page

Figure 4.16 shows the fact page, where users can view the fun facts about different dog breeds. Users can click on the refresh icon to load and display a new fact.

4.5.8 Settings Page

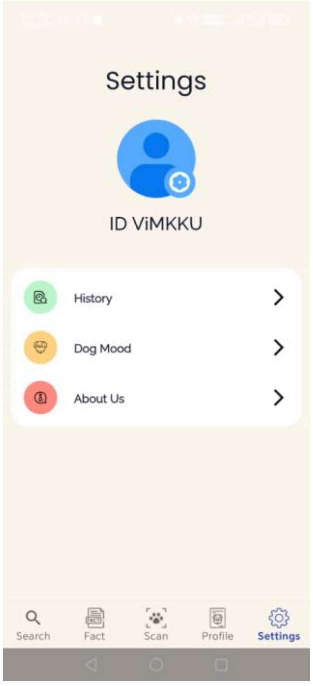


Figure 4.17: Settings Page

Figure 4.17 shows the app's settings page. This page displays the auto-generated user ID and provides navigation options for other features, including Scan History, Dog Mood, and About Us.

4.5.9 Scan History Page

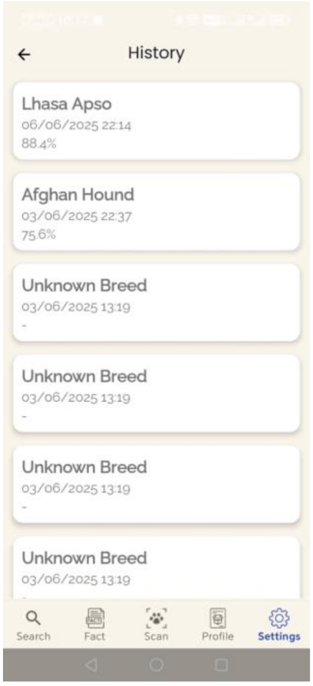


Figure 4.18: Scan History Page

Figure 4.18 illustrates the Scan History page, which displays all the recent scan results. Each entry includes the breed with the highest confidence score and the timestamp. If an unknown breed is detected, the breed's name will be replaced by “Unknown Breed,” and the confidence is shown as “-.”

4.5.10 Dog Mood Page

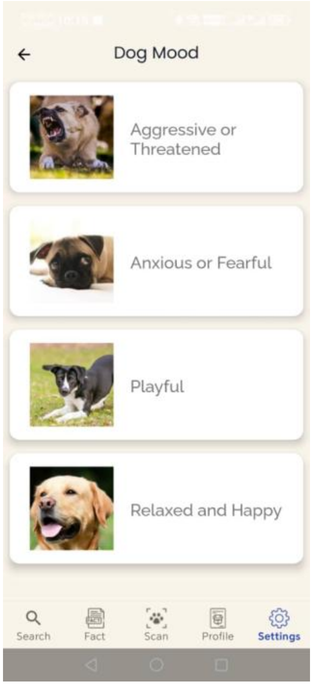


Figure 4.19: Dog Mood Page

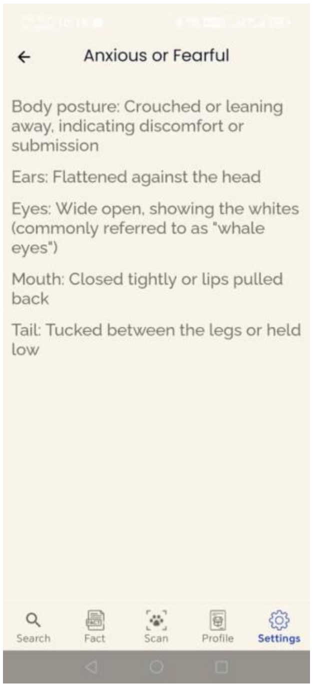


Figure 4.20: Dog Mood Detail Page

Figure 4.19 shows the Dog Mood page, which users can access from the Settings page. This page displays cards, each representing a different dog mood. The user is directed to the detailed view of that mood when taps on one card, as shown in Figure 4.20.

4.5.11 About Us Page

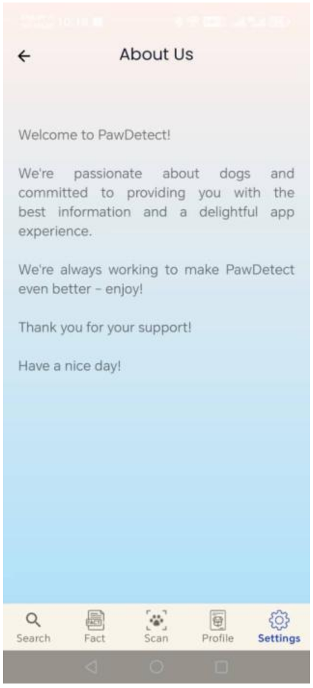


Figure 4.21: About Us Page

Figure 4.21 shows the About Us page of the PawDetect app, which provides information about the application's purpose.

4.6 Summary

This chapter describes the development and implementation of the proposed PawDetect app. It outlines the care process involved in the app, which includes image acquisition, image preprocessing, breed classification, result display, and dog profile management. This chapter also mentions the model training using the Teachable Machine, following a 70:20:10 split for training, validation, and testing. Additionally, the design and structure of the proposed app focused on usability, functionality, and simplicity to ensure a smooth user experience. The final proposed application assists users in identifying dog breeds and accessing relevant information effectively.

CHAPTER 5 : TESTING AND EVALUATION

5.1 Introduction

In this chapter, we have conducted functional and non-functional testing to evaluate the proposed PawDetect application further. This chapter includes the result from the functional testing, where the test case for most of the functions in the application is tested. We will also conduct non-functional testing for the proposed application.

5.2 Functional Testing

Before the application is released for user testing, we will conduct a test based on the test case designed to ensure the product meets the requirements. After each test case was conducted, an improvement was made to the current proposed application to ensure the user has a smooth interaction between the interfaces. Therefore, a functional test was performed to ensure the application works as planned.

5.2.1 Model Testing

The accuracy of the trained model was evaluated using the proposed PawDetect app. Out of the 20 dog breeds in the training dataset, the model successfully identified six breeds in three out of five test images, and three breeds were correctly identified in four out of five test images. Notably, 11 breeds were accurately detected in all five images. This shows the model has a strong classification performance. Out of 100 test images, the model correctly identified 85, resulting in an overall classification accuracy of 85%.

Additionally, five test images of dog breeds not included in the training set were used to assess the model's ability to handle unfamiliar inputs. The model correctly classified all five as “unknown” which indicates that the model can effectively distinguish between known and unknown breeds. These results suggest that the trained model accurately recognizes the intended dog breeds while maintaining reliability in unknown breed detection. The figure below shows the confusion matrix for the detection results of the 20 breeds and the unknown class.

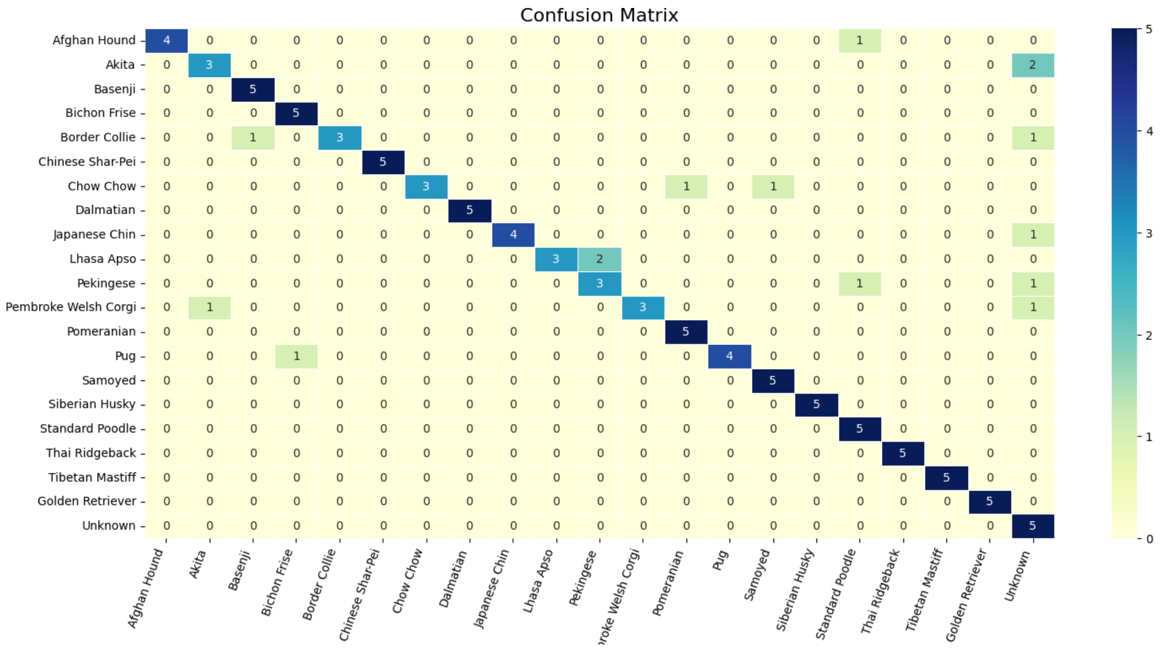


Figure 5.1: Confusion Matrix

5.2.2 Test Cases

1. Scan Page

   To test whether the user can successfully take a picture using the device's camera or choose from the gallery

2. Scan Result Page

   To test the result of identification is shown to the user

3. Search Page

   To check that the user can input the breed name to find the breed

4. Fact Page

   To check that the user can refresh the fact by the refresh button

5. Dog Profile Page

   To test that the user can create a new pet dog profile

   5.1. Basic Information Form Page

   To see that the user can input the details and proceed

   5.2. Dietary Preferences Form Page

   To see that the user can input the details and proceed

   5.3. Health Information Form Page

   To see that the user can input the details and proceed

   5.4. Daily Activities and Exercises Form Page

   To see that the user can input the details and submit the creation request

6. New Dog Profile Page

   To check that the dog profile card is successfully formed

   6.1. Dog Profile Card

   To check that the dog profile can be view, edit and delete

7. Settings Page

   To check that the user can view the unique userID and related pages

   7.1. Dog Mood Page

   To test that the user can view the dog's mood details

   7.2. History Page

   To check that the user can view the correct scan history

   7.3. About Us Page

   To check that the user can view the About us

8. Dog Breed Details Page

   To check that the user can view the details of the breed selected

<table>
<tr><td colspan="2">Test Case ID</td><td colspan="4">TC1.1</td></tr>
<tr><td colspan="2">Module Name</td><td colspan="4">Scan Page</td></tr>
<tr><td colspan="2">Test Title</td><td colspan="4">Open Camera</td></tr>
<tr><td colspan="2">Descriptions</td><td colspan="4">To test the user can successfully take a picture using the device’s camera</td></tr>
<tr><td colspan="2">Pre-Condition</td><td colspan="4">Users enable permission to use camera</td></tr>
<tr><td colspan="2">Dependencies</td><td colspan="4"></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Step</td><td>Test Procedures</td><td>Test Data</td><td>Expected Result</td><td>Actual Result</td><td>Status</td></tr>
<tr><td>1</td><td>User clicks on the button “TAKE PHOTO”</td><td>Button: Take Photo</td><td>The user should be able to open the camera</td><td>The user is directed to take a picture</td><td>PASS</td></tr>
<tr><td>2</td><td>User take a live dog picture and confirm</td><td></td><td>The user should be able to take a picture and use it, and then direct to scan result</td><td>The user can see the scan result with top three breed prediction and confidence score</td><td>PASS</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="2">Post-Condition</td><td colspan="4"></td></tr>
</table>

Table 5.1: Test Case Scan Page – Open Camera

Test Case ID	TC1.2				
Module Name	Scan Page				
Test Title	Open Gallery				
Descriptions	To test the user can successfully choose a picture from the gallery				
Pre-Condition	Users enable permission to open gallery				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	User clicks on the button "OPEN GALLERY"	Button: Open Gallery	The user should be able to open the gallery	The user is directed to choose a picture	PASS
2	User choose a dog picture from gallery		The user should be able to choose a picture and use it, and then direct to scan result	The user can see the scan result with top three breed prediction and confidence score	PASS
Post-Condition					

Table 5.2: Test Case Scan Page – Open Gallery

<table>
<tr><td>Test Case ID</td><td colspan="5">TC2.1</td></tr>
<tr><td>Module Name</td><td colspan="5">Scan Result Page</td></tr>
<tr><td>Test Title</td><td colspan="5">View Top Three Scan Result</td></tr>
<tr><td>Descriptions</td><td colspan="5">To test the top three results of identification is displayed to the user</td></tr>
<tr><td>Pre-Condition</td><td colspan="5">The user is done taking or choosing a picture</td></tr>
<tr><td>Dependencies</td><td colspan="5"></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Step</td><td>Test Procedures</td><td>Test Data</td><td>Expected Result</td><td>Actual Result</td><td>Status</td></tr>
<tr><td>1</td><td>View the top three breed prediction result</td><td></td><td>The top three prediction breeds with confidence should be shown to the user</td><td>The top three breeds are displayed along with the confidence score</td><td>PASS</td></tr>
<tr><td>2</td><td>View the picture the user uses for detection</td><td></td><td>The picture that the user takes or chooses should be shown on the result page</td><td>The picture is displayed on the result page</td><td>PASS</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Post-Condition</td><td colspan="5">The scan history will be stored in the Firebase Realtime Database under the scans section</td></tr>
</table>

Table 5.3: Test Case Scan Result Page – Top Three Result

Test Case ID	TC2.2				
Module Name	Scan Result Page				
Test Title	View Unknown Scan Result				
Descriptions	To test the unknown result of identification is displayed to the user				
Pre-Condition	The user is done taking or choosing a picture				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	View the picture that the user uses for detection		The picture that the user takes or chooses should be shown on the result page	The picture is displayed on the result page	PASS
2	View the message notifying the breed is unknown		The user should see the message declaring that the breed cannot be identified	The message "Sorry, we couldn't identify the breed" is displayed	PASS
Post-Condition	The scan history will be stored in the Firebase Realtime Database under the scans section				

Table 5.4: Test Case Scan Result Page – Unknown Result

Test Case ID	TC3				
Module Name	Search Page				
Test Title	Find Dog Breed				
Descriptions	To check that the user can input the breed name to find the breed				
Pre-Condition	The user navigates to the search page from the bottom navigation menu				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	Input the name of the dog breed in the search bar	Name: Akita	The breed card of Akita should be displayed, and other cards are gone	Only the breed card of Akita is shown	PASS
2	Input half of the breed name in the search bar	Name: terrier	All the breeds that contain the phrase “terrier” should be shown	Only the breed with the phrase “terrier” is shown	PASS
3	Input invalid breed	Name: Chihuahua	The breed should not be found, and the page is empty	The page is empty	PASS
Post-Condition					

Table 5.5: Test Case Search Page

Test Case ID	TC4				
Module Name	Fact Page				
Test Title	Refresh Fact				
Descriptions	To check that the user can refresh the fact by the refresh button				
Pre-Condition	The user navigates to the fact page from the bottom navigation menu				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	Tap on the refresh button to refresh the fact		The facts should be able to refresh, and new facts should be displayed	A new fact is displayed	PASS
Post-Condition					

Table 5.6: Test Case Fact Page

Test Case ID	TC5.1				
Module Name	Dog Profile Page				
Test Title	Create A New Pet Dog Profile				
Descriptions	To test that the user can create a new pet dog profile				
Pre-Condition	The user navigates to the profile page from the bottom navigation menu				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	The user clicks on the button “GET STARTED”	Button: Get Started	The user should be able to be directed to the basic information form	The basic information form is displayed to the user	PASS
Post-Condition					

Table 5.7: Test Case Dog Profile Page

<table>
<tr><td>Test Case ID</td><td colspan="5">TC5.2</td></tr>
<tr><td>Module Name</td><td colspan="5">Basic Information Form</td></tr>
<tr><td>Test Title</td><td colspan="5">Input Basic Information</td></tr>
<tr><td>Descriptions</td><td colspan="5">To test that the user can input the details and proceed</td></tr>
<tr><td>Pre-Condition</td><td colspan="5">The user starts to create the dog profile</td></tr>
<tr><td>Dependencies</td><td colspan="5"></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Step</td><td>Test Procedures</td><td>Test Data</td><td>Expected Result</td><td>Actual Result</td><td>Status</td></tr>
<tr><td>1</td><td>Input all the details</td><td></td><td>The user should be able to input into all fields</td><td>The user can input into all fields</td><td>PASS</td></tr>
<tr><td>2</td><td>Click on the next button and direct to the next page</td><td>Button: Next</td><td>The user should be able to proceed to the dietary preferences page</td><td>The user directed to the dietary preferences page</td><td>PASS</td></tr>
<tr><td>3</td><td>Click on the cancel button to go back to the dog profile page</td><td>Button: Cancel</td><td>The user should be able to go back to the dog profile page</td><td>The user is directed to the dog profile page</td><td>PASS</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Post-Condition</td><td colspan="5"></td></tr>
</table>

Table 5.8: Test Case Basic Information Form

Test Case ID	TC5.3				
Module Name	Dietary Preferences Form				
Test Title	Input Dietary Preferences				
Descriptions	To test that the user can input the details and proceed				
Pre-Condition	The users complete the basic information				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	Input all the details		The user should be able to input into all fields	The user can input into all fields	PASS
2	Click on the next button and direct to the next page	Button: Next	The user should be able to proceed to the health information page	The user is directed to the health information page	PASS
3	Click on the back button to return to the basic information page	Button: Back	The user should be able to go back to the basic information page	The user is directed to the basic information page	PASS
Post-Condition					

Table 5.9: Test Case Dietary Preferences Form

Test Case ID	TC5.4				
Module Name	Health Information Form				
Test Title	Input Health Information				
Descriptions	To test that the user can input the details and proceed				
Pre-Condition	The users complete the dietary preferences				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	Input all the details		The user should be able to input into all fields	The user can input into all fields	PASS
2	Click on the next button and direct to the next page	Button: Next	The user should be able to proceed to the daily activities page	The user is directed to the daily activities page	PASS
3	Click on the back button to return to the dietary preferences page	Button: Back	The user should be able to back to the dietary preferences page	The user is directed to the dietary preferences page	PASS
Post-Condition					

Table 5.10: Test Case Health Information Form

Test Case ID	TC5.5				
Module Name	Daily Activities and Exercises Form				
Test Title	Input Activity Details				
Descriptions	To test that the user can input the details and proceed				
Pre-Condition	The user completes the health information				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	Input all the details		The user should be able to input into all fields	The user can input into all fields	PASS
2	Click on the back button to return to the health information page	Button: Back	The user should be able to go back to the health information page	The user is direct to the health information page	PASS
3	Click on the submit button to save the dog information	Button: Submit	The user should be able to save all the input data and direct to new dog profile page	The user successfully saved the dog profile and was directed to the new dog profile page	PASS
Post-Condition	The dog profile is saved to the Firebase Realtime Database under the section named dog profiles				

Table 5.11: Test Case Daily Activities and Exercises Form

Test Case ID	TC6.1				
Module Name	New Dog Profile Page				
Test Title	Display Dog Profile Card				
Descriptions	To ensure the created dog profile card appears correctly				
Pre-Condition	The user already created a dog profile				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	View the dog profile card		The dog profile card should appear with the dog's name and breed	The dog profile card with the dog's name and breed appear	PASS
2	Click on the "CREATE NEW PROFILE" button to build a new profile	Button: Create new profile	The user should open the empty forms and input the information	The empty forms are open, and the user can input the information	PASS
Post-Condition					

Table 5.12: Test Case New Dog Profile Page

Test Case ID	TC6.2				
Module Name	Dog Profile Card				
Test Title	View, Edit, and Delete Dog Profile				
Descriptions	To ensure the created dog profile card can be viewed, edited, and deleted				
Pre-Condition	The user already created a dog profile				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	Click on the blue edit button and change the data	Button: Edit	The user should be directed to the forms, and the form already filled with saved data	The forms with saved data are shown, and the user can edit	PASS
2	Click on the red delete button and delete the profile	Button: Delete	A confirmation dialog should pop out and ask the user to confirm the deletion	The dialog is shown, and the user clicks on yes to delete the profile	PASS
3	Click on the profile card to view all the information		he profile card should be able to be clicked, and the user should be directed to the detail page	The user can view all the dog profile details	PASS
Post-Condition	The dog profile data is saved or deleted from the database				

Table 5.13: Test Case Dog Profile Card

Test Case ID	TC7.1				
Module Name	Settings Page				
Test Title	View Other Pages				
Descriptions	To check that the user can view the unique userID and related pages				
Pre-Condition	The userID already been created				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	View userID		The userID should display to the user	The userID displayed to the user	PASS
2	Click on the go button to view the history	Button: Go	The history page should be open	The history page is open	PASS
3	Click on the go button to view the dog mood	Button: Go	The dog mood page should be open	The dog mood page is open	PASS
4	Click on the go button to view the About us	Button: Go	The About us page should be open	The About Us page is open	PASS
Post-Condition					

Table 5.14: Test Case Settings Page

Test Case ID	TC7.2				
Module Name	Dog Mood Page				
Test Title	View Detailed Information				
Descriptions	To test that the user can view the dog's mood details				
Pre-Condition	The user navigates to the settings page using the bottom navigation menu				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	View four cards with mood names		Four dog mood cards should be shown	Four dog mood cards are shown	PASS
2	Tap on the dog mood card		The user should be able to view the dog's mood details	The user can view the dog's mood details	PASS
3	Click the back button at the top left corner		The user should be able to return to the settings page	The user returns to the settings page	PASS
Post-Condition					

Table 5.15: Test Case Dog Mood Page

Test Case ID	TC7.3				
Module Name	History Page				
Test Title	View Scan History				
Descriptions	To test that the user can view the scan history				
Pre-Condition	The user navigates to the settings page using the bottom navigation menu				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	View the scan history cards		The history cards with breed name, confidence percentage, and timestamp should be displayed	The history cards with breed name, confidence percentage, and timestamp are displayed	PASS
2	Click the back button at the top left corner		The user should be able to return to the settings page	The user returns to the settings page	PASS
Post-Condition					

Table 5.16: Test Case History Page

Test Case ID	TC7.4				
Module Name	About Us Page				
Test Title	View About Us				
Descriptions	To test that the user can view the about us				
Pre-Condition	The user navigates to the settings page using the bottom navigation menu				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	View about us		The notes from the author should be displayed	The notes from the author are displayed	PASS
2	Click the back button at the top left corner		The user should be able to return to the settings page	The user returns to the settings page	PASS
Post-Condition					

Table 5.17: Test Case About Us Page

Test Case ID	TC8				
Module Name	Dog Breed Details Page				
Test Title	View Dog Breed Details				
Descriptions	To check that the user can view the details of the breed selected				
Pre-Condition	The user already opens the breed card				
Dependencies					
Step	Test Procedures	Test Data	Expected Result	Actual Result	Status
1	View the breed details		The user should see five sections of information	The user sees five sections of information	PASS
2	Expand or collapse each section		The user should be able to expand and collapse each information section	The user can expand and collapse each information section	PASS
3	Click the back button at the top left corner		The user should be able to return to the previous page	The user returns to the previous page	PASS
Post-Condition					

Table 5.18: Test Case Dog Breed Details Page

5.3 Non-Functional Testing and Analysis

The user testing was conducted physically where the .apk was installed on the developer's phone and let the respondents test the app. After trying the app, the respondents request to answer the Google Form questionnaire. We received a total of 30 responses. The survey is divided into demographics, general feedback, additional feedback, and suggestions.

5.3.1 Section 1: Demographics

The demographics section gathered the age, gender, and dog ownership distribution. Figures 5.2 to 5.4 show the results of this section.

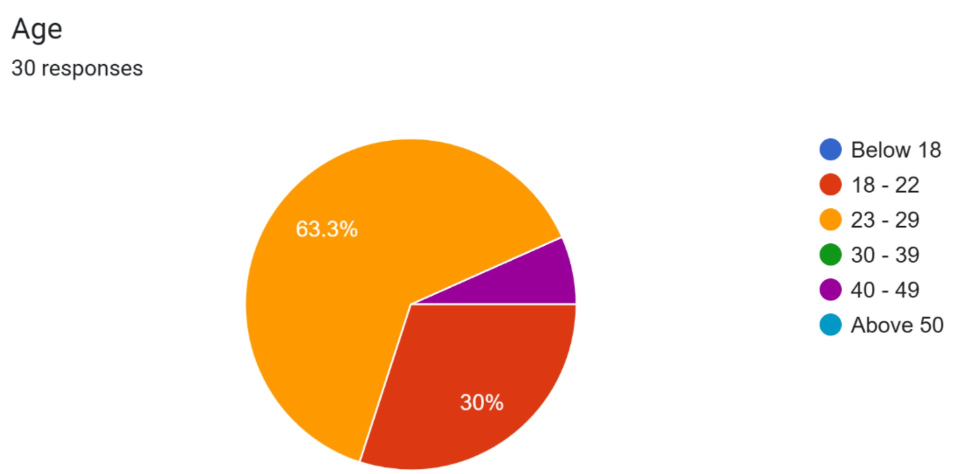


Figure 5.2: Pie Chart – Age Distribution

Figure 5.2 displays the age distribution of the survey. Of the 30 respondents, the largest age group was 23-29, comprising 19 individuals (63.3%). This was followed by the 18-22 age group with nine respondents (30%). The 40-49 age group included two respondents (6.7%).

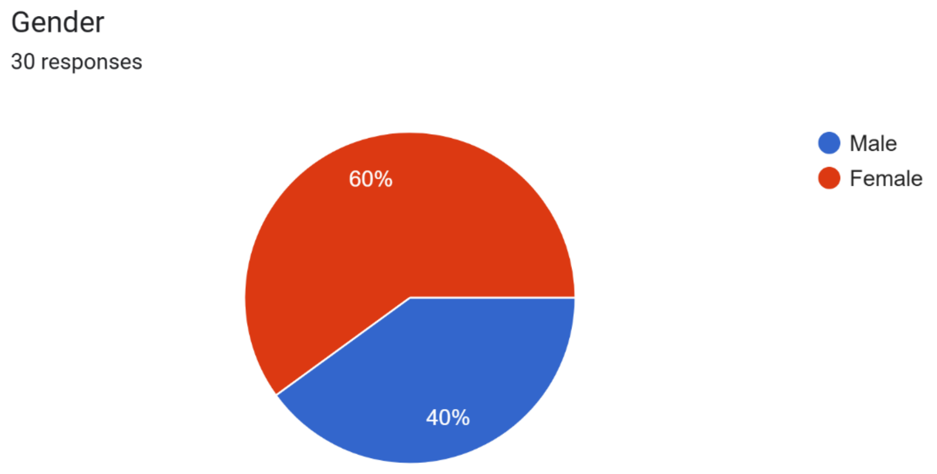


Figure 5.3: Pie Chart – Gender Distribution

For the gender distribution, 12 (40%) respondents are male, and 18 (60%) are female.

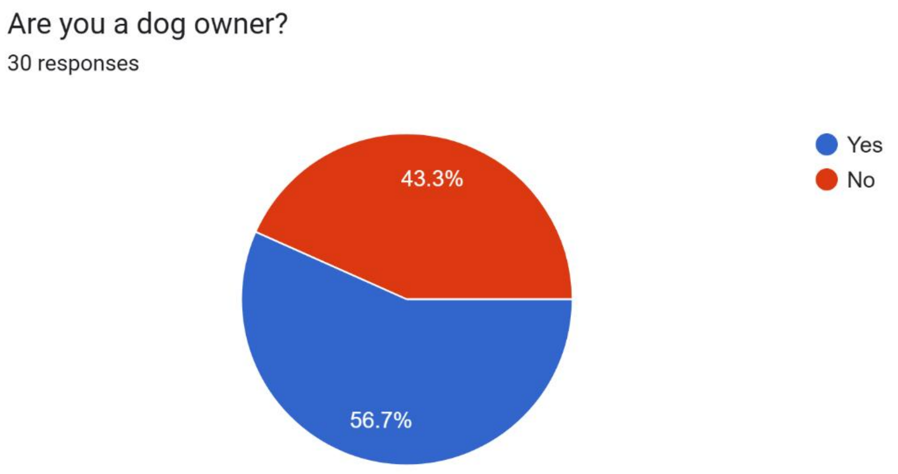


Figure 5.4: Pie Chart - Dog Ownership Distribution

Figure 5.4 shows the dog ownership distribution of 30 respondents. 13 (43.3.%) respondents indicated they are dog owners, while 17 (56.7%) stated they are not.

5.3.2 Section 2: General Feedback

Section 2 asks about the users' perceptions of the app's functionality and design after the testing. A 5-point Likert scale was used, with one representing strongly disagree and five representing strongly agree. Figures 5.5 to 5.13 display the responses from the respondents.

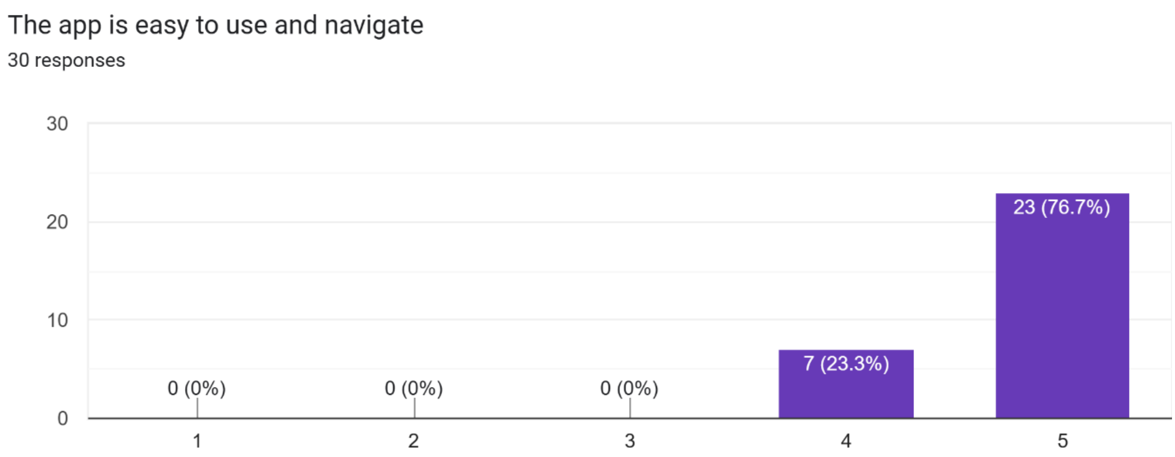


Figure 5.5: Bar Chart – App's Ease of Use

Figure 5.5 illustrates the responses about the app's ease of use. 23 (76.7%) respondents strongly agree that the app is easy to use and navigate. The remaining seven (23.3.%) respondents agree with this statement.

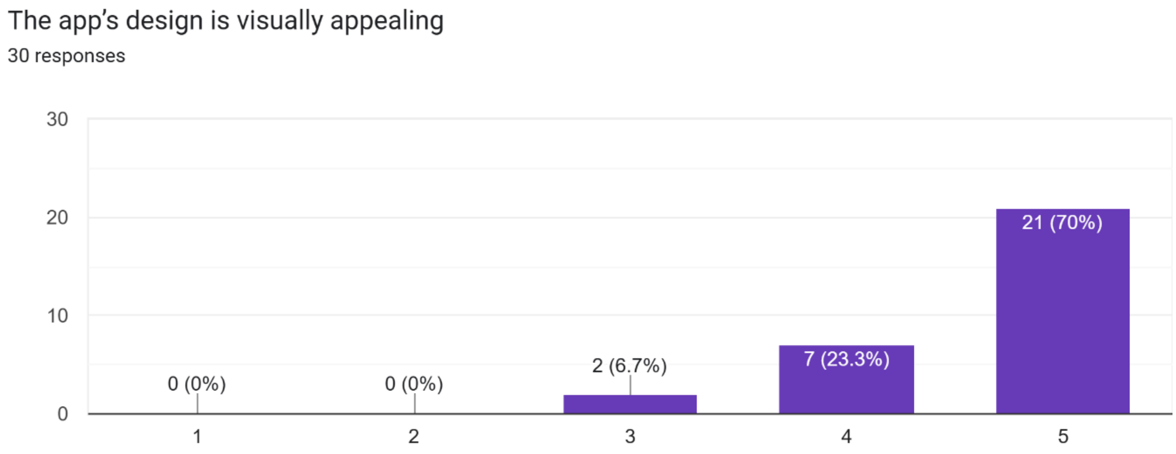


Figure 5.6: Bar Chart – App's Design

The second question evaluates the app's design, specifically its visual appeal. The majority of the respondents, 21 (70%), strongly agree that the app is visually attractive, while seven (23.3%) agree. The remaining two (6.7%) respondents have a neutral opinion.

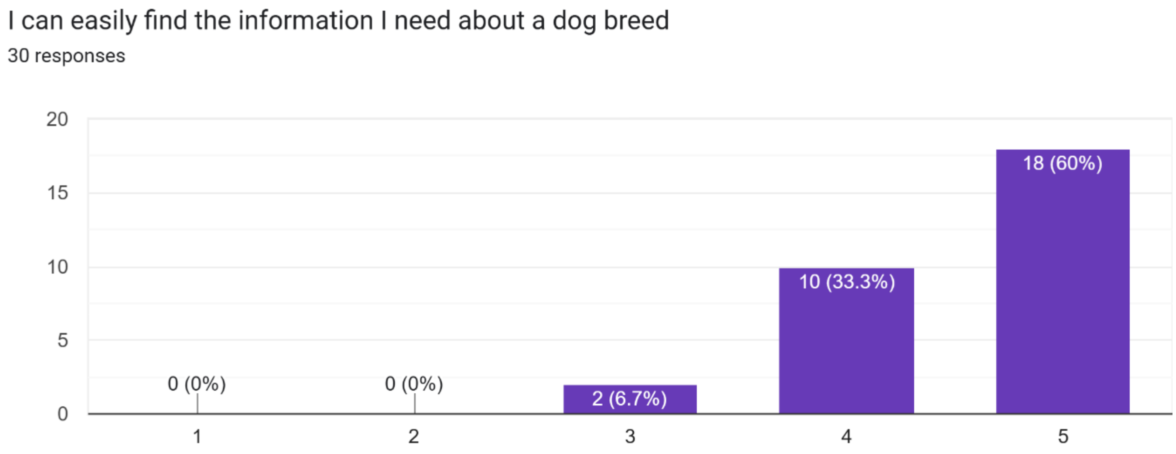


Figure 5.7: Bar Chart – Ease to Find Information

Next is the ease of finding information about a dog breed. According to Figure 5.7, 18 (60%) respondents strongly agree that finding information about a dog breed is easy. Among the 12 remaining respondents, 10 (33.3%) agree with the statement, while two (6.7%) remain neutral.

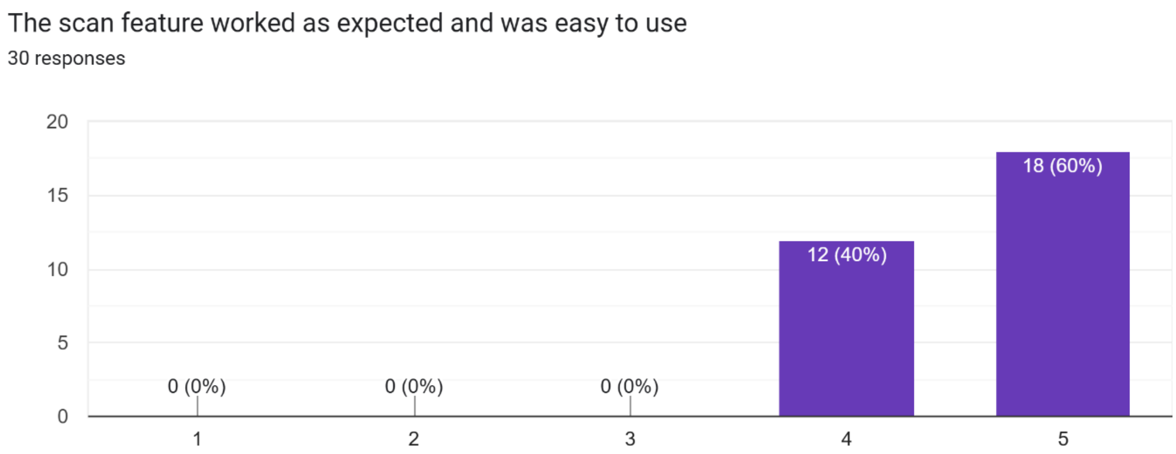


Figure 5.8: Bar Chart – Scan Feature's Effectiveness

Figure 5.8 shows the result of the question about the scan feature's effectiveness and ease of use. Of 30 respondents, 18 (60%) strongly agree that the scan feature works as expected and is easy to use, while 12 (40%) agree with this statement.

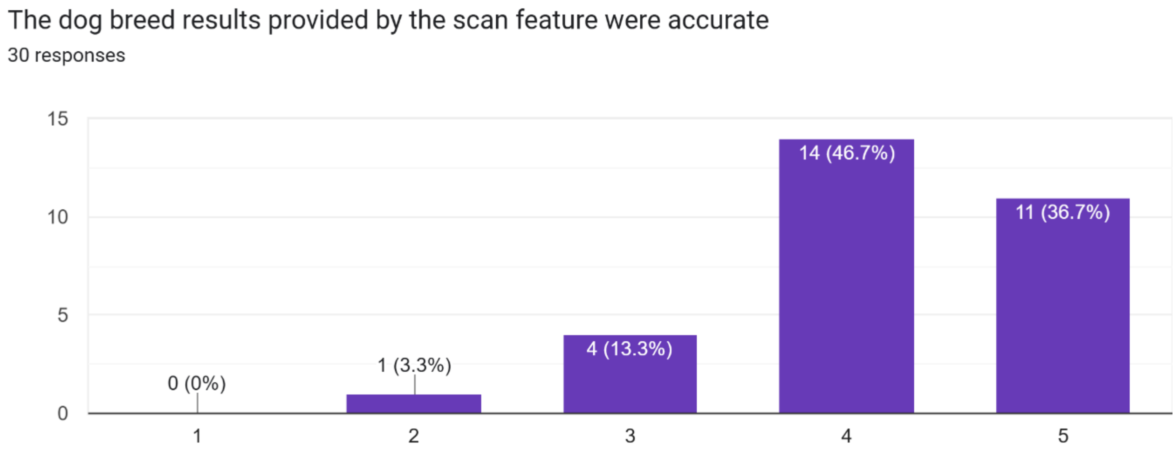


Figure 5.9: Bar Chart – Accuracy of Dog Breed Results

Figure 5.9 depicts the respondents' perception of the accuracy of the dog breed results. For this question, the highest response rating was four (Agree), where 14 (46.7%) respondents agree that the dog breed results provided by the scan feature are accurate. Next followed by 11 (36.7%) respondents strongly agreed with the statement. Four respondents (13.3.%) hold a neutral opinion, and one (3.3%) disagrees with this statement.

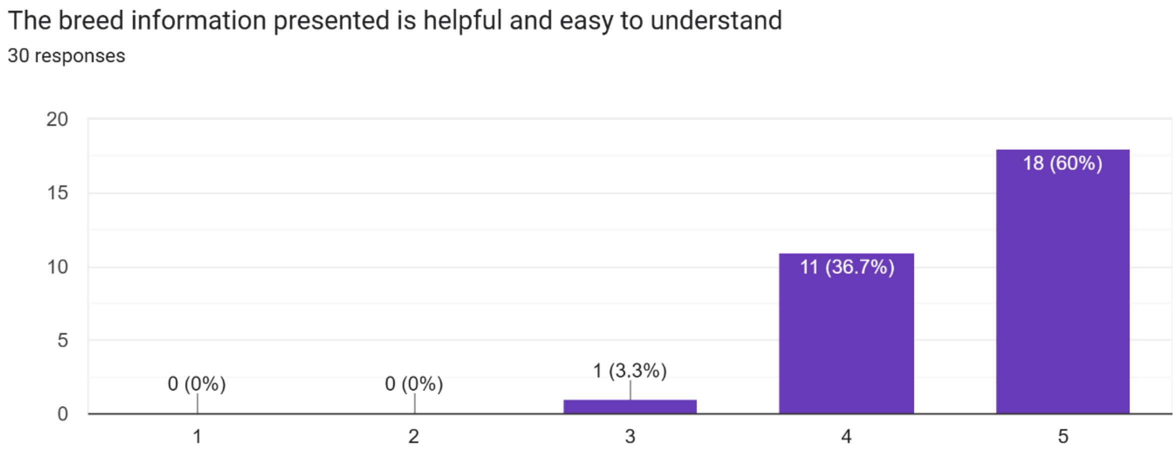


Figure 5.10: Bar Chart – Helpfulness of Breed Information

The next question is about the helpfulness of the breed information given in the app. Respondents are asked whether the breed information was helpful and easy to understand. One respondent (3.3%) expressed a neutral opinion, 11 respondents (36.7%) agreed with the statement, and 18 (60%) strongly agreed with the statement.

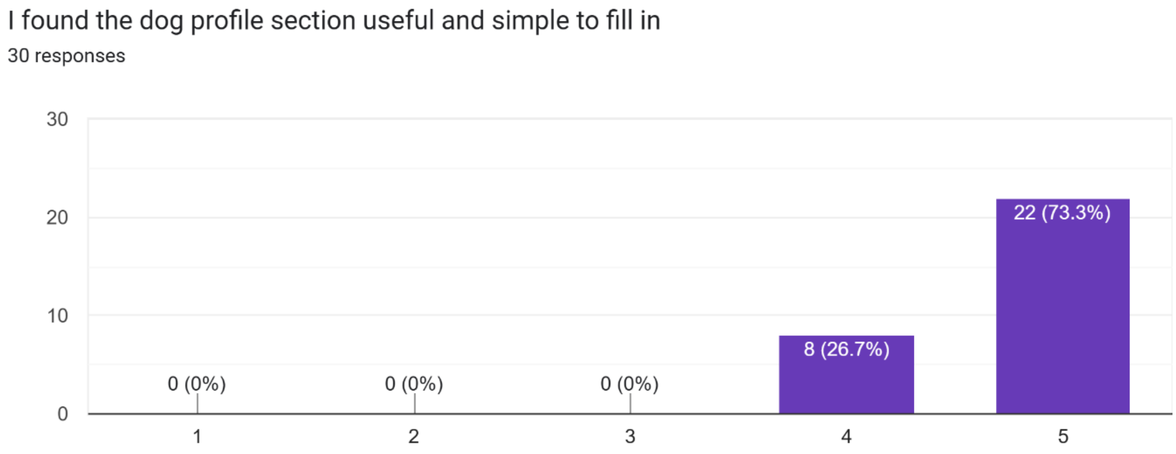


Figure 5.11: Bar Chart – Simplicity of Dog Profile Section

Figure 5.11 illustrates the respondents' views on the simplicity of the dog profile section. Most respondents, 22 (73.3%), strongly agree that the dog profile section is helpful and straightforward to fill in. Eight (26.7%) respondents agree with the statement.

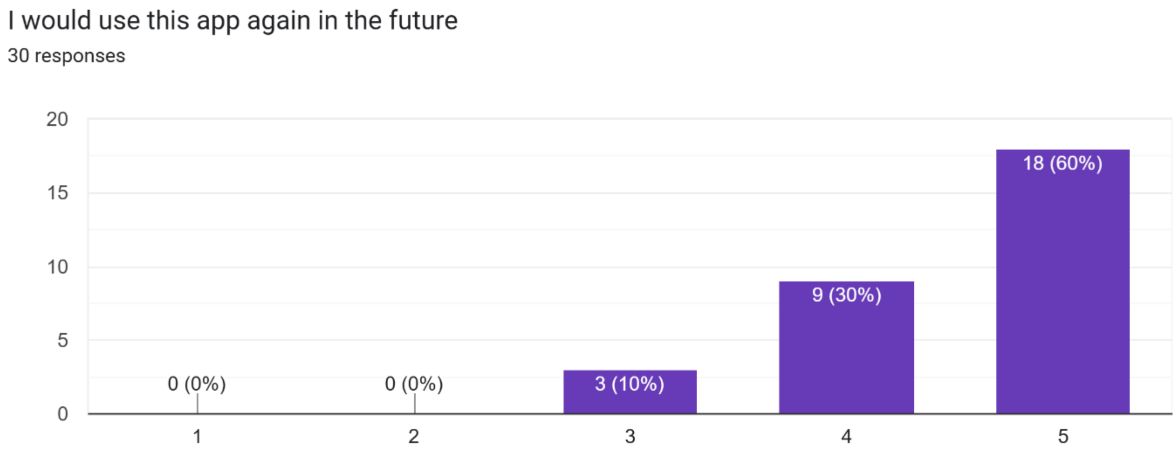


Figure 5.12: Bar Chart – Future Use of the App

Figure 5.12 shows the respondents' perception of the statement that they would use the app again in the future. Among 30 respondents, 18 (60%) strongly agreed with the statement, while nine (30%) agreed. The remaining three (10%) respondents were neutral toward the statement.

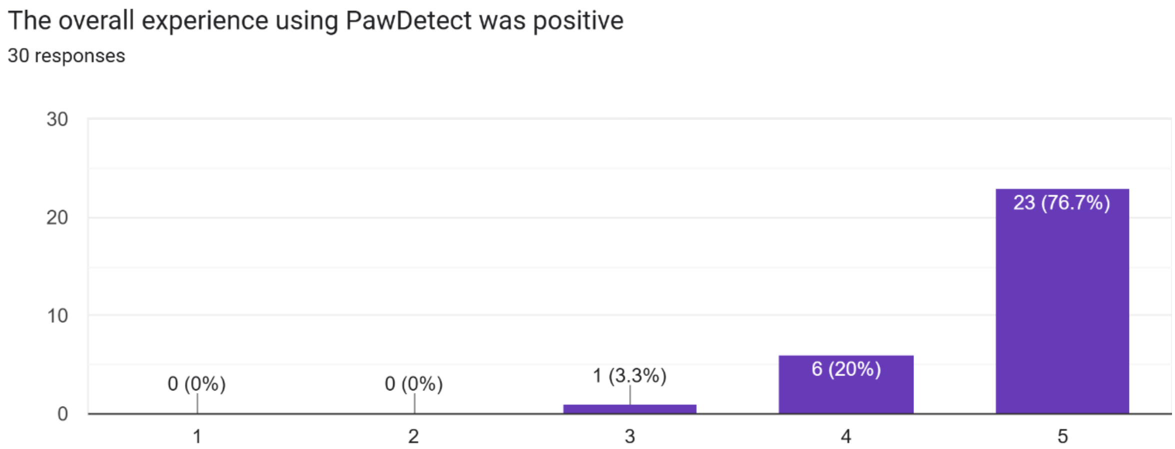


Figure 5.13: Bar Chart – Overall Experience

Figure 5.13 depicts the respondent's overall experience of testing the app. 23 (76.7%) respondents strongly agree that the overall experience of using the app is positive. Among the remaining seven respondents, six (20%) agreed with the statement, while one (3.3%) was neutral.

5.3.3 Section 3: Additional Feedback and Suggestions

Section 3 consists of three open-ended questions and one choice question.

Responses	**Count**
Scan dog breed and detect it	17
Facts	8
Easily find the species of dog	3
Create dog profile	2

Table 5.19: Feature that found most useful

Table 5.19 shows the responses to the first question: the feature respondents found most useful in the proposed PawDetect app. 17 respondents said that the app's scan and detect dog breed feature is the most useful. Eight respondents reported that the fact function was the most useful. Three respondents responded that they could easily find the dog species using the app, while two respondents said that creating a dog profile is the most helpful function in the app.

Responses	Count
The inaccuracy of dog breed detection	4
Less of the dog picture	1
No	25

Table 5.20: Features that didn't like or confuse

Table 5.20 depicts the second question, which is the feature that respondents dislike or confuse. Most of the respondents, 25, said that they do not dislike or are confused about the app's function. Four respondents disliked the dog breed detection inaccuracy, and one complained about the few dog pictures in the app.

Responses	Count
It can be more colorful	2
The function can be more diverse	1
Add more pictures	2
Extensive dog breeds to be added	2
Can add multi-language	1
No suggestion	22

Table 5.21: Suggestions to improve function or design

Table 5.21 shows suggestions from the respondents on how to improve the app. 22 respondents did not provide recommendations. Among the remaining responses, two suggested that the app could be more colorful. One respondent suggested that the function can be more diverse. Two respondents suggested adding more pictures, while two indicated adding extensive dog breeds. The final respondent recommended implementing multi-language support.

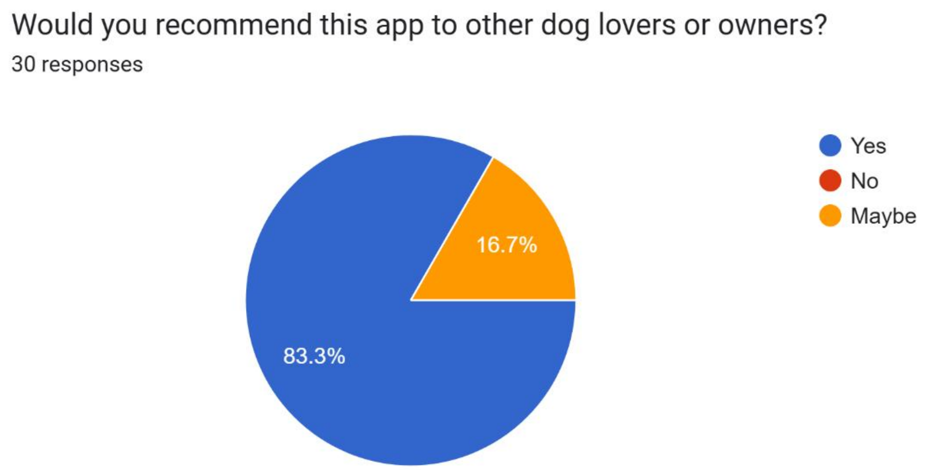


Figure 5.14: Pie Chart – App Recommendation

Figure 5.14 displays the app recommendation among respondents. Most of the respondents, 25 (83.3%), indicated that they would recommend the proposed PawDetect to others, while the remaining 5 (16.7%) respondents responded with “maybe.”

5.4 Summary

This chapter presents the test cases of the proposed PawDetect app and the findings gathered through user testing. Most respondents responded positively through the app's design, ease of use, and the scan result's accuracy. Most respondents also indicated that they would use the app again. The respondents also provide suggestions for improving the app's design and functionality. The responses are valuable in enhancing the app's user experience.

CHAPTER 6 : CONCLUSION AND FUTURE WORKS

6.1 Introduction

In this chapter, the conclusion of this project is made. We will also explain the limitations of our proposed application and the possible future works on the related topics.

6.2 Fulfilment of Objectives

By the end of this project, the objectives stated in Chapter 1 had been successfully achieved. Further details are as follows:

1. Develop an Android mobile application (PawDetect) that allows the user to identify the dog breed through an image classification system, create pet dog profiles, view fun facts about dogs, and provide dog care guidance.
2. Implement and integrate an image classification model into the app using TensorFlow Lite, which enables the detection of 20 dog breeds with the support of breed information fetched from the external API and the Firebase database.

6.3 Limitations and Constraints

There are some limitations faced during the development of the application. First, the user cannot input the image since the Firebase Realtime Database and Firestore cannot support uploading the photos. If we insist on keeping the function to upload images to the database, a subscription to Firebase Storage is needed. This situation means that the scan history and the dog profile cannot have the image to support it.

Additionally, the proposed application needs to have an internet connection since it needs to fetch the data from the online API and the back-end database. Another limitation encountered during the app development is that the API is not fully open and accessible. It needs to be subscribed to have access to the breed details information. To overcome this limitation, the breed details information is fetched from the American Kennel Club (AKC) (American Kennel Club, n.d.) and input into the Firebase Firestore. Hence, the user can view both general and specific information.

There are also limitations to displaying the breed details information fetched from AKC. The information saved in the database is in paragraphs and cannot be saved in the point form. This may make it hard for the user to read a short information section and make a bad user experience.

6.4 Future Work

Several enhancements can be made in future development. The first is to expand the breed detection since the app supports the detection of 20 breeds. The model could be extended in future growth to recognize a broader range of dog breeds to increase the app's usefulness. Besides, the app can be improved by implementing multiple languages like Bahasa Melayu and Mandarin to reach more audiences. Additional features could be added to PawDetect to make the app more functional for dog owners. For example, setting vaccination schedules and reminders can help users manage the important dates of their pet dog.

6.5 Summary

This chapter highlights the conclusion of this project, the limitations faced, and the enhancements that can be made in the future. We can conclude that the PawDetect app can be an educational tool for dog owners and lovers. The app effectively supports users in identifying dog breeds with image classification and provides related breed information.

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APPENDIX A: QUESTIONNAIRE GOOGLE FORM

Exploring User Needs for Dog Breed Identification Survey

Hello! My name is **Jasmine Tiong Wan Yun**, and I am currently a final-year undergraduate student from Multimedia Computing (MC) at the Faculty of Computer Science and Information Technology (FCSIT), University Malaysia Sarawak (UNIMAS). As a part of my final year project, I am developing **PawDetect: Breed Identifier for Dogs.** The app aims to assist users in identifying local dog breeds and receiving detailed information about the breed. Thus, this survey is conducted to better understand your needs and gather insights from you.

I would like to invite you to participate in this research project. This survey is divided into four (4) sections:

- **Section 1 : Demographics**
- **Section 2 : Experience with Existing App**
- **Section 3 : Desired Features and Design**
- **Section 4 : Overall Feedback**

The survey will take approximately 5–15 minutes to complete, and all responses will remain confidential. Your feedback is highly valued and will greatly contribute to my research.

If you have any questions or concerns about this survey, please feel free to reach out to me at **79628@siswa.unimas.my**

Thank you for your participation!

* Indicates required question

Declaration of consent

I hereby declare that:

1. I have been informed about the purpose of this questionnaire, which is to gather data for the project of dog breed identification.
2. I understand that my participation in this survey is entirely voluntary, and I have the right to withdraw at any time without providing a reason.
3. I acknowledge that my responses will be kept confidential and used solely for the purpose of this research project.
4. I consent to my data being analyzed and reported in the project in a manner that does not reveal my identity.

By proceeding with the questionnaire, I confirm that I have read and understood the information provided above and agree to participate in this survey.

Mark only one oval.

◯ Agree

Skip to question 2

Section 1: Demographics

2. Age *

Mark only one oval.

- Below 18
- 18 - 22
- 23 - 29
- 30 - 39
- 40 - 49
- Above 50

3. Gender *

Mark only one oval.

- Male
- Female

4. Race *

Mark only one oval.

- Malay
- Chinese
- Indian
- Iban

Bidayuh Other:

5. Employment status *

Mark only one oval.

- Student
- Employed
- Unemployed
- Self-employed
- Retired

6. Do you own a dog or plan to get one in the future? * *Mark only one oval.*

- Yes
- No

7. How familiar are you with dog breeds? *

Mark only one oval.

	1	2	3	4	5	
Not familiar at all						Very familiar

Section 2: Experience with Existing App

8. Have you ever tried an app that identifies dog breeds? *

Mark only one oval.

Yes, please specify *Skip to question 9*

No *Skip to question 14*

Other: ____________________

Section 2: Experience with Existing App (for user)

9. How frequently do you use such apps? * *Mark only one oval.*

Daily

Weekly

Monthly

Occasionally

Rarely

As needed

10. What purpose do you primarily use such apps for? (Select all that apply) *

Check all that apply.

- [ ] Identifying the breed of a dog
- [ ] Learning about different dog breeds
- [ ] Finding care or feeding tips for a specific breed
- [ ] Discovering common health issues or risks of certain breeds
- [ ] Reporting or learning about stray or lost dogs

Other: ______________________________

11. What features do you find most helpful in the existing apps? (Select all that* apply)

Check all that apply.

- [ ] Accurate breed identification
- [ ] Easy image scanning or uploading
- [ ] Detailed breed descriptions
- [ ] User-friendly interface
- [ ] Recommendations for dog care Other:

____

12. What problems or frustrations do you face when using these apps? (Select all * that apply)

Check all that apply.

- [ ] Difficult or inaccurate scanning results
- [ ] Confusing interface
- [ ] Lack of local breed information
- [ ] Insufficient breed care tips Ads
- [ ] or unnecessary notifications
- [ ] Other: ______________________

13. How would you rate your overall experience with such apps? *

Mark only one oval.

	1	2	3	4	5	
Very poor	◯	◯	◯	◯	◯	Excellent

Skip to question 21

Section 2: Experience with Existing App (for non-user)

14. Have you ever wanted to identify the breed of a dog you saw or owned? *

Mark only one oval.

◯ Yes

◯ No

15. What would you expect a dog breed identification app to do? (Select all that * apply)

Check all that apply.

☐ Quickly identify the breed using a photo

☐ Provide detailed breed information (e.g., size, lifespan, temperament)

☐ Offer tips on caring for the breed (e.g., feeding, exercise) Suggest

☐ similar breeds if the breed cannot be identified

☐ Other: ______________________

16. What would you like to know most about a dog breed? (Select all that apply) *

Check all that apply.

- [ ] Feeding and care tips
- [ ] Exercise and activity needs
- [ ] Temperament and behavior traits
- [ ] Health risks or common medical conditions
- [ ] History or origin of the breed
- [ ] Other:____________________________

17. How would you prefer to interact with the app to identify a dog's breed? *

Mark only one oval.

- ( ) Take a live photo of the dog
- ( ) Upload an existing photo
- ( ) Both

18. Would you be interested in additional features, such as: *

Check all that apply.

- [ ] Saving breed pro les for future reference
- [ ] Connecting with local dog owners for advice
- [ ] Recommendations for nearby shelters or vets
- [ ] Notifications about dog care tips and reminders
- [ ] Other: ____________________________________

19. What would make you trust the accuracy of the app's breed identification? * (Select all that apply)

Check all that apply.

- [ ] Verified information sources
- [ ] High accuracy rating
- [ ] User reviews and feedback
- [ ] Detailed explanations for breed identification results
- [ ] Other: ______________________________

20. Do you think a focus on local dog breeds is important? Why or why not? *

____

____

____

____

____

Skip to question 21

Section 3 : Desired Features and Design

21. What features would you like to see in the PawDetect app? (Select all that apply) *

Check all that apply.

- [ ] Image scanning to identify dog breeds
- [ ] Detailed breed profiles (e.g., size, lifespan, temperament)
- [ ] Feeding and care guidelines specific to the breed
- [ ] Information on local dog breeds
- [ ] Health recommendations (e.g., common diseases for the breed)
- [ ] Comparison between breeds (e.g., similarities and differences)
- [ ] Fun facts about the breed
- [ ] Favorites feature to bookmark breed pro les
- [ ] Notifications for dog care tips and reminders
- [ ] Recommendations for nearby shelters and vets
- [ ] History of identified breeds (past scan)
- [ ] Customize profile for own pets
- [ ] Other: ______________________________

22. What would make the app feel user-friendly to you? (Select all that apply) *

Check all that apply.

- [ ] Simple navigation with clear menus
- [ ] Visual cues like icons or animations
- [ ] Short text instructions
- [ ] An intuitive design that required minimal effort to learn
- [ ] Personalized options like save favorite breeds
- [ ] Other: ______________________________

23. Would you like personalized content based on your dog or preferences? *

Mark only one oval.

- Yes, I'd like tips and advice tailored to my dog's breed
- No, I prefer general information
- I prefer both general and specific content

24. How important is the accuracy of the breed identification feature to you? *

Mark only one oval.

	1	2	3	4	5	
Very unimportant	◯	◯	◯	◯	◯	Very important

25. What type of interface design would you prefer for PawDetect? *

Mark only one oval.

- Simple and minimalist
- Bright and colorful
- Informative with lots of details
- Fun and interactive (e.g., animations, icons) Other:
- ______________________________

26. What color theme would you prefer for the PawDetect app? *

Mark only one oval.

- Bright and vibrant (e.g., yellow, orange, bright blue)
- Calm and soothing (e.g., pastel colors, light blue, soft green)
- Natural tones (e.g., earth tones like brown, beige, or forest green)
- Minimalist and clean (e.g., black, white, grey)
- Other: ______________________________

27. What additional suggestions do you have for the app's features or design? *

Skip to question 28

Section 4 : Overall Feedback

28. Would you be willing to test a prototype version of the PawDetect app? *

Mark only one oval.

- Yes
- No

29. Do you have any specific suggestions for the PawDetect app?

Skip to section 8 (THANK YOU FOR THE RESPONSE)

THANK YOU FOR THE RESPONSE

APPENDIX B: FEEDBACK QUESTIONNAIRE GOOGLE FORM

PawDetect App Usability & Feedback Survey

Hello! My name is **Jasmine Tiong Wan Yun**, and I am currently a final-year undergraduate student from Multimedia Computing (MC) at the Faculty of Computer Science and Information Technology (FCSIT), University Malaysia Sarawak (UNIMAS).

Thank you for participating in the testing of **PawDetect**, an app designed to help identify local dog breeds and provide care tips for each breed.

This questionnaire is part of an academic research project and aims to gather your feedback on the app's usability, functionality, and overall user experience.

This survey is divided into three (3) sections:

- **Section 1 : Demographics**
- **Section 2 : General Feedback**
- **Section 3 : Additional Feedback And Suggestions**

The survey will take approximately 5 minutes to complete, and all responses will remain confidential. Your feedback is highly valued and will greatly contribute to my research.

If you have any questions or concerns about this survey, please feel free to reach out to me at **79628@siswa.unimas.my**

Thank you for your participation!

* Indicates required question

Section 1: Demographics

1. Age *

   Mark only one oval.

   - Below 18
   - 18 - 22
   - 23 - 29
   - 30 - 39
   - 40 - 49
   - Above 50

2. Gender *

   Mark only one oval.

   - Male
   - Female

3. Are you a dog owner? * *Mark only one oval.*

   - Yes
   - No

Skip to question 4

Section 2: General Feedback

4. The app is easy to use and navigate * *Mark only one oval.*

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

5. The app's design is visually appealing * *Mark only one oval.*

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

6. I can easily find the information I need about a dog breed *

Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

7. The scan feature worked as expected and was easy to use *

Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

8. The dog breed results provided by the scan feature were accurate *

Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

9. The breed information presented is helpful and easy to understand *

Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

10. I found the dog profile section useful and simple to fill in *

Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

11. I would use this app again in the future *

Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

12. The overall experience using PawDetect was positive *

Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

Skip to question 13

Section 3: Additional feedback and Suggestions

13. Which feature did you find the most useful and why? *

14. Are there any features you didn't like or found confusing? *

15. Do you have any suggestions for improving PawDetect's function or design? *

16. Would you recommend this app to other dog lovers or owners? *

Mark only one oval.

- Yes
- No
- Maybe

THANK YOU FOR THE RESPONSE