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A Rule-based Mobile Application for Diagnosing Pet Disease: Design and Implementation

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Abstract— **Animals kept in homes for personal enjoyment rather than for work or sustenance are typically referred to as "pets." A pet's daily schedule can include exercising its muscles and going outside to relieve stress. Pets may occasionally be drink from community water dishes that could be contaminated with other animals' bacteria, viruses, or parasites. The pets may unknowingly get infections due to this opening up their bodies to bacteria or viruses. Pet's behavior and condition need to be periodically checked. An animal's behavior is directly impacted by its health and vice versa. A pet disease diagnosis application is crucial for pet owners to receive consistent and suitable pet health care. It will help pet owners identify potential illnesses before their animals develop chronic ones. Thus, the construction of a mobile application for diagnosing pet diseases is presented in this paper. This application offers pet owners information on their animals' health and safety. Pet owners can contact veterinarians for rare cases or crises in this application's chat room. The rule-based inference is used to determine the possible diseases based on the pet's symptoms. System prototyping methodology is applied to develop this Android mobile application using Visual Studio Code and Firebase database. User acceptance testing is performed on the users to test how much further their satisfaction with the proposed pet disease diagnosis application is before the application is shifted to the production process.**

Keywords— **Rule-based; veterinary; pet disease diagnosis.**

I. INTRODUCTION

Pets usually refer to the animals at home for pleasure, rather than ones kept for work or food [1]. Pet kept a companion and was treated kindly by the owner, such as cats and dogs. Pets must be cared for by their owners by providing healthy food, a safe and cozy shelter, and especially health care [2]. A pet's daily routine may include going outside to relieve stress, discharge sadness, and train its muscles. Sometimes the pet will drink out of community water bowls that could contain bacteria, viruses, or parasites from other animals. As a result, bacteria or viruses can enter their bodies, and the pets will unintentionally get diseases [3]. The pet's conditions and behavior must be observed from time to time. An animal's health directly impacts its behavior and vice versa [4]. A medical issue may be the sole or partial cause of some behavioral issues. A comprehensive exam is needed for pets to prevent dangerous diseases if abnormal behavior or symptoms occur. Pet owners should be concerned about the health care issue of their pets. All the clues shown on the pet

may help vets diagnose the disease more accurately so that the pet can receive effective treatment to cure the disease [5]. People do not widely use the system for diagnosing pet diseases remotely. The most common step to diagnosing pet disease is visiting the veterinary clinic. When they arrive at the veterinary clinic, they are required to register their information and the pet's information including the pet's condition and health history [6].

After that, they must wait to meet the veterinarian for an examination. In addition, a pet is needed to be further checked and observed if there is an in-depth inspection. The veterinary clinics are also needed to book an appointment before visiting. However, the problems encountered by pet owners make them unable to bring their pets to veterinary care. The common problem is the expensive veterinary care due to the high cost of vet technology, medicines, and veterinary services. In addition, the lack of knowledge of pet owners about the pet's health care will cause medication errors to pets. The shortages of veterinary clinics in rural areas also become

a factor in pet owners giving up the opportunity to treat their pet's diseases [7], [8].

Therefore, a pet disease diagnosis application is the essential alternative to deliver standard and adequate health care for pets so that the pet owner may diagnose probable diseases before their pets become chronically unwell. In this paper, a pet disease diagnosis application is developed to determine the possible diseases of the pet based on the pet's symptoms. The pet owner may be offered some alternatives or tips to make the next step to treat their pets [9]. This application also provides information and knowledge about pet issues and health care to fulfill the information the pet owner needs. Lastly, this application provides a chat room for the pet owner to consult specific vets for a special case or if there is an emergency problem.

II. MATERIALS AND METHOD

A. Veterinary

Veterinary medicine, often known as veterinary science, is a professional specialty that deals with the prevention, management, diagnosis, and treatment of illnesses that impact the health of domestic and wild animals and the prevention of transmission of infection from animals to humans [10]. Interspecies relationships are a feature of veterinary care, and human and animal diagnoses can intersect and get linked.

Veterinarians' primary concerns are and have always been wellness, sickness prevention, and rehabilitation. This responsibility extends not just to the health of animals used in food production but also to the health of animal owners, the general population, and consumer and environmental health. As a result, the foundation for justifying veterinary treatments is seen as health. Veterinary treatments are procedures on a living animal's body; they can be benign, but they can also be dangerous, life-threatening, or even fatal. Treatments are only permitted if they are aimed at enhancing animal care or are determined to be beneficial to animal health. Returning an animal to its initial condition is associated with regaining its health [11].

When an animal is sick or hurt, a veterinarian evaluates to establish the cause of the illness, a technique known as "diagnosis." The veterinarian then delivers the necessary medications to aid the animal's healing. Veterinarians have examined animal illness concerns by doing a thorough examination to determine the basis of the condition. As a result, that appropriate test and control method has been implemented. Clinical examination is one of the most important tools for identifying animals brought to the clinic. Clinical examination in veterinary medicine is defined as the study of anatomy, physiology, pathology, and animal behavior, as well as abilities in clinical examination methods and procedures, clinical signs, and disease pathophysiology, all of which are essential for a competent diagnostic approach [12].

A veterinarian can assess the unhealthy animals presented to a veterinary clinic. The vet engages the owner by inquiring about his or her complaint and then requesting professional help by providing the animal's history. Focusing on collecting patient records, present, past, and environmental history suited to patient animals may result in an accurate and thorough of the patient. The veterinarian might approach the animals using the restraining method to handle them safely.

B. Veterinary Clinic

It is crucial to keep an eye on your pet's health to ensure that it remains as robust and healthy as possible. When a pet exhibits aberrant behavior or becomes ill, the owner should take it to a veterinarian facility for an expert diagnosis. The vet always listened to their concerns, discussed their choices and solutions, and involved them in the whole veterinary appointment.

They could keep their pet because they trusted the veterinary team and felt community service was necessary. The perspectives of pet owners and veterinarians on information sharing and therapeutic decision-making in companion animal medicine are also critical in accomplishing the therapy's objectives [13]. A pet owner needs to acquire understandable information regarding the origins and consequences of a disease, as well as viable therapeutic options. This allows pet owners to participate in the medical decision-making process, as well as manage the unpredictability that comes with disease and create optimism for the future.
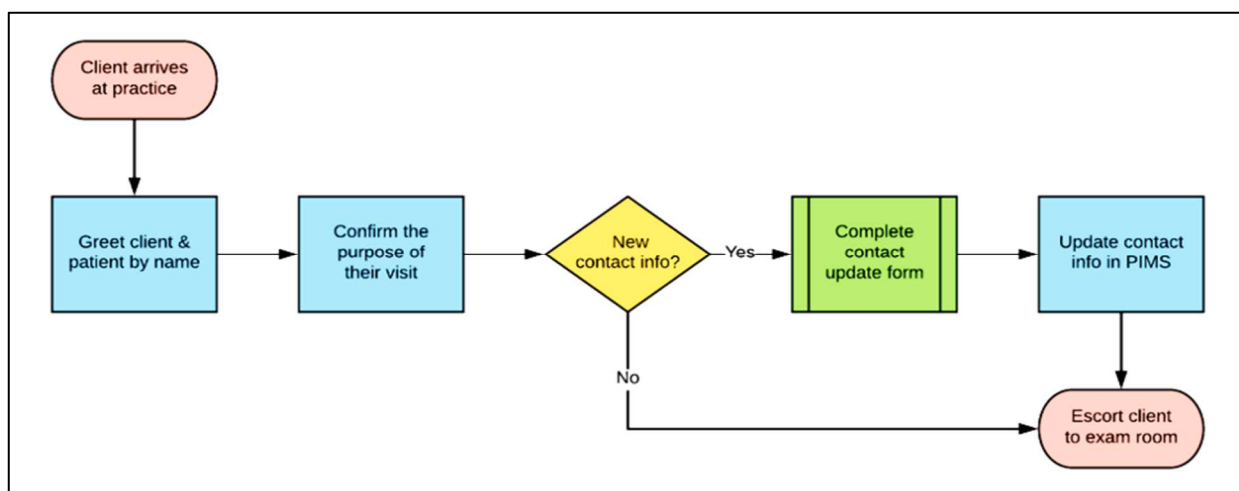

Fig. 1 Flowchart of Visiting Veterinary Clinic

Fig. 1 depicts the process of obtaining a diagnosis for a pet at a veterinary clinic [14]. When the pet owner arrives at the clinic, they may meet the receptionist by giving their information as well as pet information and verify the reason for their visit. They may then wait their turn for a professional diagnosis and vet consultation for their pet after the discussion.

C. Pet Diseases

Although pets always give their great companions to their owners, pet owners should be aware that sometimes cats can carry harmful germs that can cause a variety of illnesses in people, ranging from minor skin infections to serious illnesses [15]. Vaccination protection is necessary for pets to prevent serious diseases such as cancer and feline leukemia. Vaccinations can help protect the cat from dangerous diseases and help them live a healthier life, reducing the risk of getting the disease significantly.

Pet owners should tell the veterinarian about the cat's lifestyle, whether indoor or outdoor or both, and if there are other animals at home the cat may encounter. Pet owners can ask the veterinarian about other vaccines owners may need or want for the cat to effectively prevent the high possible diseases. Various types of cat diseases may cause the cat to go into a dangerous health condition. The cat's behavior and symptoms should be observed occasionally to prevent the disease from entering the body. The common cat diseases and their symptoms and solutions are listed in Table 1. All the listed descriptions are from the American Society for the Prevention of Cruelty to Animals [16] and Hill's Pet [17].

TABLE I
CAT DISEASES AND ITS SYMPTOMS

Cat Diseases	Symptoms
Ringworm	Hair loss with scaly or crusty skin
Flea allergy dermatitis	Itching - inflammation
Rabies	Change in behavior - paralysis - disorientation - seizures
Cancer	Swelling - skin infections - weight loss - diarrhea or vomiting - bad breath
Diabetes	Weight loss - excessive thirst and urination - sweet-smelling breath
Kidney Disease	Diarrhea and Vomiting - frequent urination - bloody or cloudy urine
Feline Leukemia Virus (FeLV)	Fever - diarrhea and vomiting - loss of appetite and weight loss - enlarged lymph nodes
Heartworm	Persistent cough - depression Sporadic vomiting
Feline immunodeficiency virus (FIV)	Loss of appetite - fever Chronic or recurring infections

Cat Diseases	Symptoms
Gingivitis	Redness - swelling - discomfort - bleeding gums - cry or yowl when eating
Obesity	Diabetes - joint problems - difficulty in walking - sleeping more than usual
Broken bones	Limping - swelling - hiding behavior

Based on the information in Table 1, owners of pets can move on with curing their cats by following the advice and solutions provided. In the event of an emergency, such as a seizure, it can be crucial for pet owners to acquire first aid techniques. First aid treatment cannot replace veterinary care but may prolong pet's life while waiting for medical attention.

D. Rule-based Inference

The proposed application will use rule-based inference to diagnose cat diseases. According to Lizelle Conradie [18], "a rules-based approach to regulation prescribes how to behave in detail or gives a set of rules." It enables the representation of subjective expertise about a certain issue area as a set of distinct constraints. It is frequently utilized in numerous kinds of technology from multiple fields, and a rule-based system can act as an advisor, issue solver, specialist, or decision-maker within these areas [19].

Facts and IF-THEN rules are used to encode information. In many contexts, these industrial principles enable the simple encoding of specialized knowledge. The IF section of the rule describes features of a scenario that lead to one or more of the actions listed in the THEN section. The criterion is a set of assertions that must be accurate for the condition to be triggered, the action is a process to follow that may be taken if the condition is true, and the outcome is a claim that remains true if the statement is fulfilled [20]. To express knowledge in a generic form, rules are utilized. It works in the same way as the brain's long-term and short-term memories do.

Fig. 2 shows the rule engine. A rule-based system is made up of a rule base, an inference engine, and a working memory. The information will be gathered as rules and saved in various datasets. The inference engine will choose rules depending on the specification and execute them to result. If any of the conditions are met, it takes the appropriate steps and provides the result to the user. Match, resolve, and execute are the three steps of the inference engine's operation [21]. The facts and data are evaluated to the set of rules by the inference engine. The system then handles the sequence of competing constraints, mediates the dispute, and assigns the chosen ruleset. Finally, the inference engine applies the specified rule to the input and returns the results to the user.
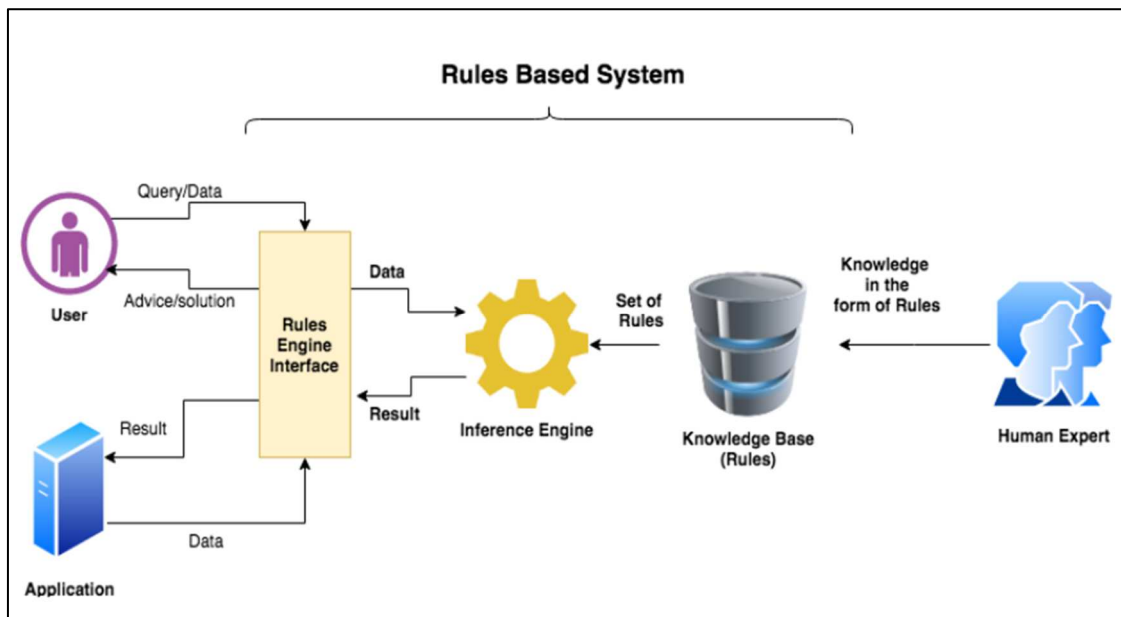
Fig. 2 Rule Engine

E. Existing Systems Review

The literature demonstrates the development of existing systems and applications with similar features to the proposed system. The PetMD Symptom Checker is a system found on the PetMD website and in the Apple App Store, but the PetMD application is not available in Malaysia. PetMD supports pet owners in handling the tough times of pets by delivering thorough, trustable, and latest pet health information [22]. Users are allowed the tools, advice, and information users require to keep their pets healthy. This system was primarily designed for cats and dogs. Approximately 2,000 pet healthcare articles and news are provided by PetMD for users to search based on the symptoms that pets face.

Pet Coach is a specific system that delivers the quickest guidance and pet care tips that are provided by verified pet specialists and veterinarians [23]. Pet Coach offers a web-based system as well as a mobile application. Their mobile application is available for Android users via Google Play Store and for iOS users via Apple Play Store. Users can sign up for an account using Facebook, Apple, Google, or email. In a user account, more than one pet profile can be registered. Thus, the Pet Coach account can be linked to the vet or practice to access the pet's medical record such as the medical history, prescriptions, lab work, reminders, and appointments.

Vets4Pets is a company in the United Kingdom that started to introduce veterinary services in their practice in 2001. A set of pet care and counseling is offered to pets so that the pet deserves happiness and healthy life [24]. The Vets4Pets services are provided for a variety of animals, including dogs, cats, reptiles, rabbits, fish, and other small pets. A comprehensive range of veterinarian services, such as basic animal disease treatments, regular checkups and advice, and urgent medical surgeries, are ready to be delivered to pets.

F. Technology Used

This pet disease diagnosis application is an Android mobile application. Visual Studio Code is used as a software to develop a mobile-based application, while Firebase is a database that is used to store all the data of the proposed application.

The Android platform comprises a Linux-based operating system, a graphical user interface (GUI), a web browser, and downloadable end-user apps. The kernel, hardware abstraction layer, Android runtime, libraries, application framework, and apps are among the layers [25]. It is people-centric and expressive, with a redesigned controls space and greater privacy options. Debugging, task execution, and version control are all supported by Visual Studio Code [26]. The goal is to give only the developer's required equipment for a speedy code-build-debug cycle, leaving more complicated processes to a more powerful and flexible Integrated Development Environment (IDE). Firebase is a Google development tool kit that assists developers in constructing high-quality systems quickly [26]. Users may work with each other to retrieve their data from any device, website, or mobile app. Users may create serverless mobile apps using Realtime Database's mobile and web SDKs.

Pet Buddies is a mobile application for Android that offers the service of pet ailment diagnosis based on the pet's symptoms. It primarily focuses on cats by offering a symptom checker to identify cat sickness. This software helps users find correct information on cat diseases and provides first aid advice to cat owners so they can treat their pets in case of an accident or other emergency when getting to a vet is difficult or impossible. To raise pet owners' knowledge of their pets, Pet Buddies also provides a collection of information on pet health care.

Pet owners can also use a free veterinary consultation service to resolve their pet health care issues. This proposed application can be updated and improved based on any input relating to the application and services that are provided to the app. A system design diagram is a high-level overview of existing or upcoming software [27]. It is indeed a simple design that can be created interactively in a brief period and

provides users with a distinct, complete, and comprehensive explanation of the purpose. Fig. 3 shows the system design diagram for the proposed application, which consists of admin, pet owner, vet, user interface, database, and each of the features for each user such as login, register, feedback, pet health article, pet disease diagnosis, vet consultation, and vet account management.
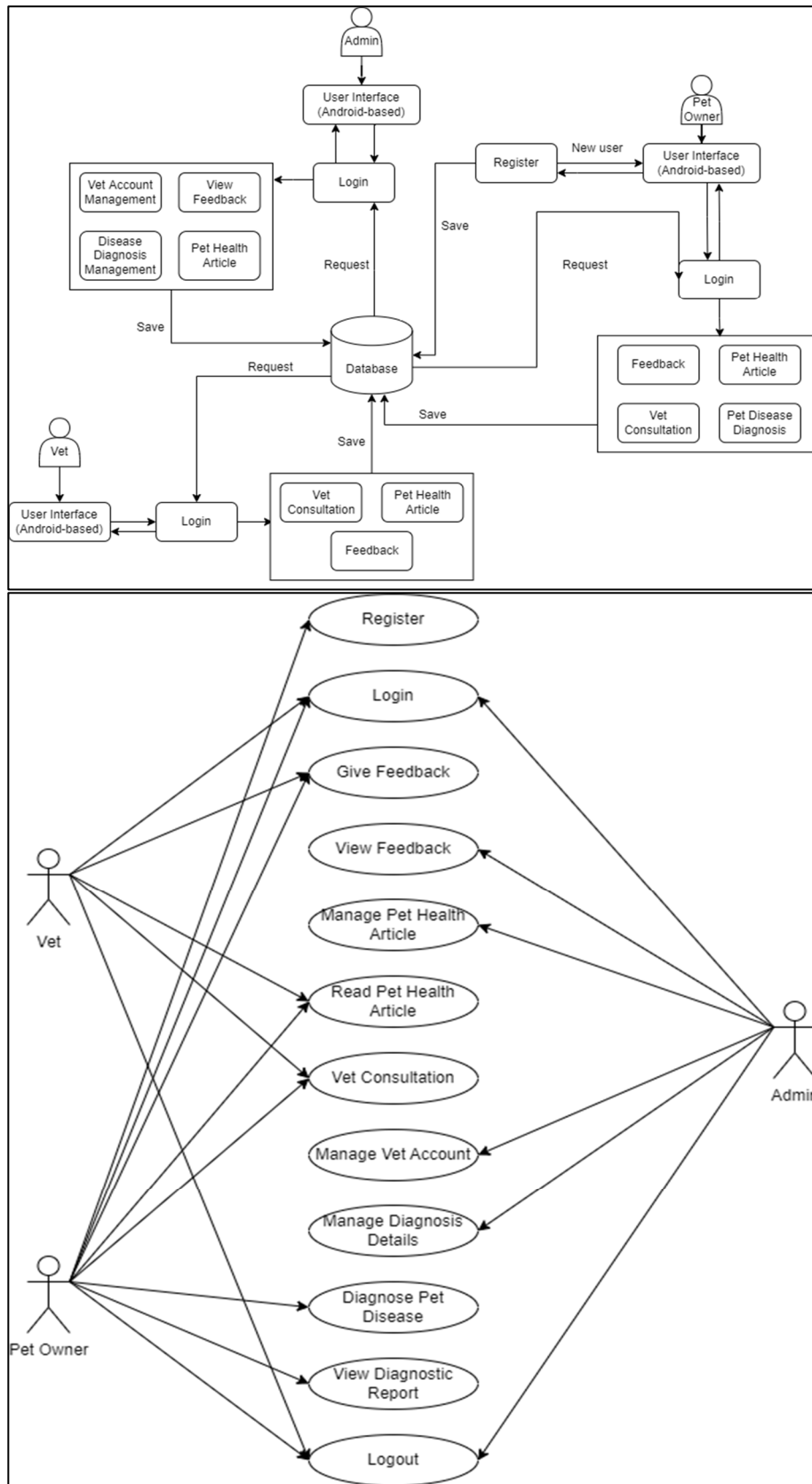

Fig. 3   Pet Buddies' diagram for (a) System design (b) Use case

It is important to do routine inspections of pets' behavior and health. The condition of an animal's health and behavior are inversely correlated. It is essential to have a disease diagnosis application for pets in order to be able to give pets proper and suitable medical care. This enables pet owners to identify any illnesses in their animals before they become chronically ill. As a result, this study has established the structure diagram of an application for identifying diseases affecting pets. The suggested application's capabilities are compared to current application programs.

III. RESULT AND DISCUSSION

The proposed application's basic module interfaces are shown in Fig. 4. Users must enter their name and email address and confirm their password while creating an account. In addition, to log into the application, the user must provide an email address and a password. If a user wishes to log out of the application, they may go to their profile page and click the logout button.
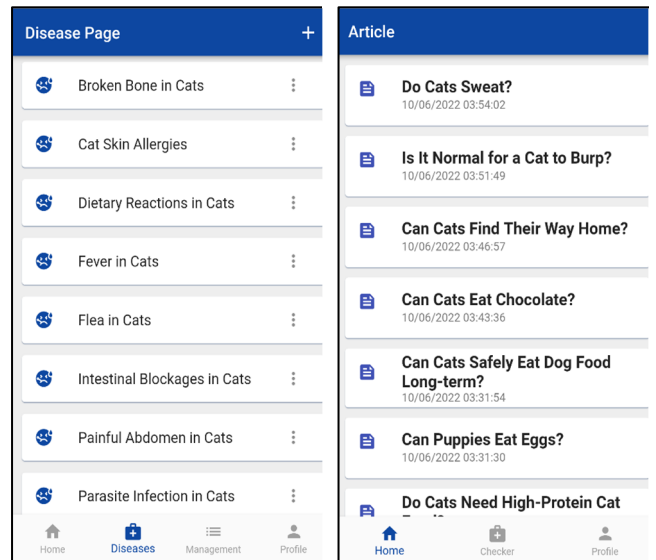

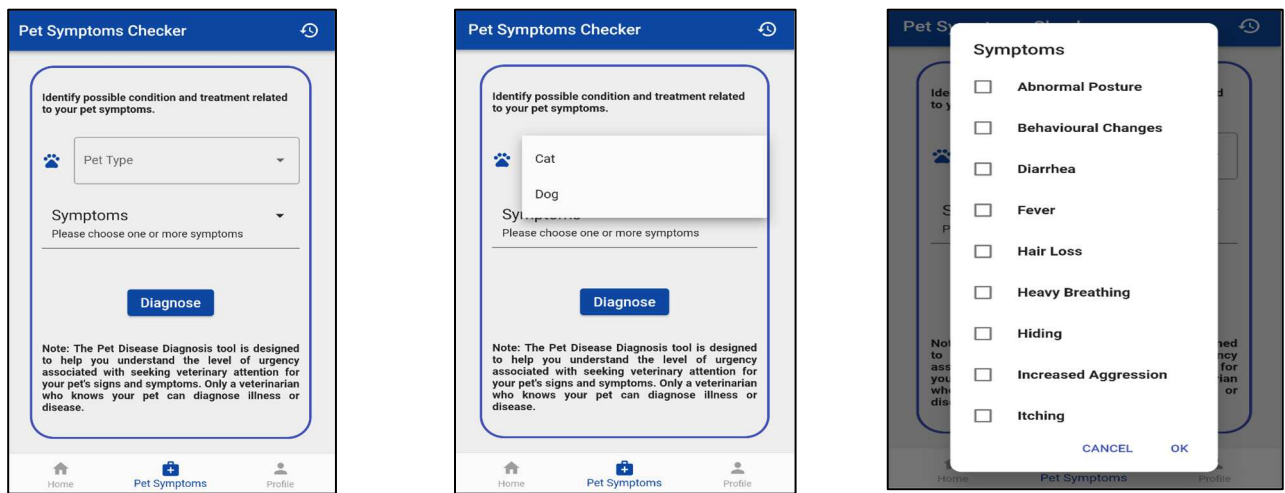Fig. 4 Pet Buddies' interface design for (a) disease page (b) article page

Fig. 5 Pet Buddies' interface design for diagnosis module

The user may see a list of article titles on the main page. The user may also access the article's information by clicking the widget. Fig. 5 shows the symptoms checker, diagnosis history, and diagnostic report. By selecting the history icon button in the upper right corner, the user may read the diagnosis history. The user may choose the type of pet and any related symptoms. The pet type and symptoms options are taken from the Fire store's pet type and symptoms collection. The pet type and symptom options can be revoked at any time.
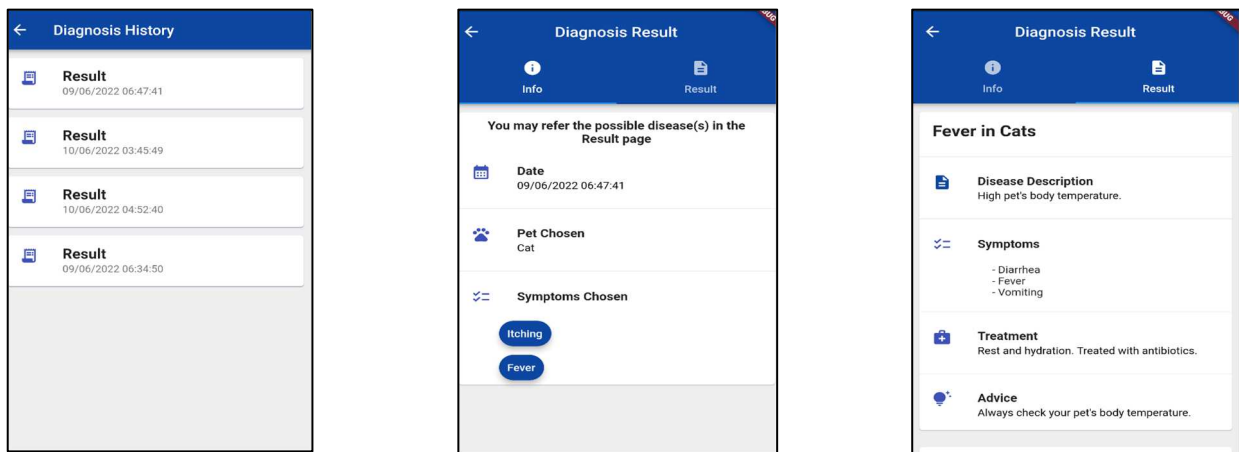

Fig. 6 Pet Buddies' interface design for diagnose report module

After selecting the pet type and symptoms, as in Fig. 6, the user will receive an instant diagnostic report with two tabs. The first tab contains diagnostic data, such as the diagnostic date, pet type, and symptoms selected by the user. The second tab contains a list of possible diseases, each with its name, description, symptoms, treatment, and advice. The report can also be viewed again later on the diagnosis history page.

The name of the pet type can be entered in the add pet type form by the admin. If the admin wants to rewrite the content or does not want the content typed out right now, the reset button is used to clear the entire form. Update and delete pet types are the two purposes of the three dots icon button, as displayed in Fig. 7.
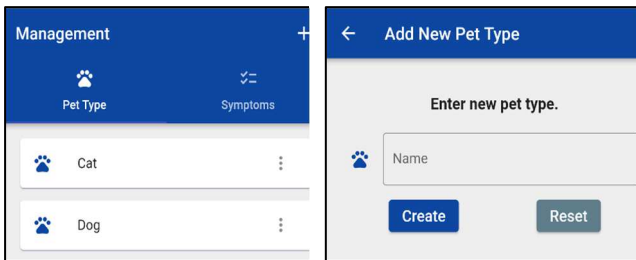

Fig. 7 Pet Buddies' interface design for pet management

Fig. 8 shows symptom management, including creating symptoms, displaying the symptom list, and updating pet-type interfaces for the admin view. Admin can alter the symptom name by clicking the update button. When an admin deletes a symptom, the symptom item is removed from the list.
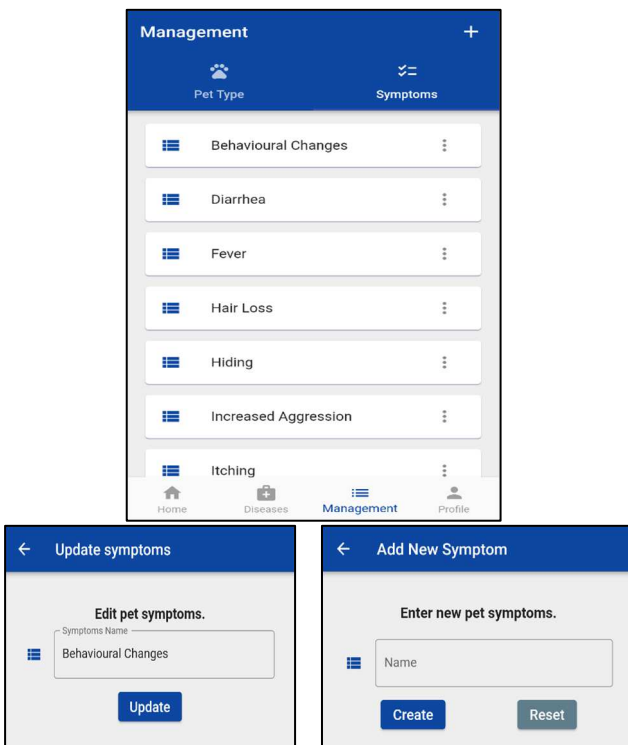

Fig. 8 Pet Buddies' interface design for pet's symptoms management

User acceptance testing (UAT) is performed on the users to test how much further their satisfaction with the proposed pet disease diagnosis application is before the application is shifted to the production process. User acceptance testing is conducted through Google Forms to provide users an opportunity to use the application and measure their acceptance level toward this application. Twenty respondents were invited to be involved in the user acceptance testing, of which five respondents tested for the admin part, and 15 respondents tested for the pet owner part.

All the respondents are satisfied and highly satisfied with the register, login, and diagnostic history functions. Some of the respondents feel good about the pet articles, pet symptoms checker, and feedback function. Overall, the respondents accept the functions offered in the proposed application. Fig. 9 explains the satisfaction level for functionality testing, and Fig. 10 shows the satisfaction level on interface design for the application.
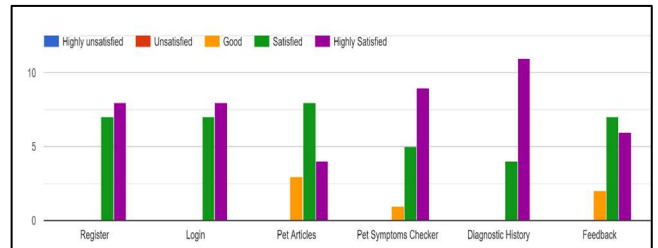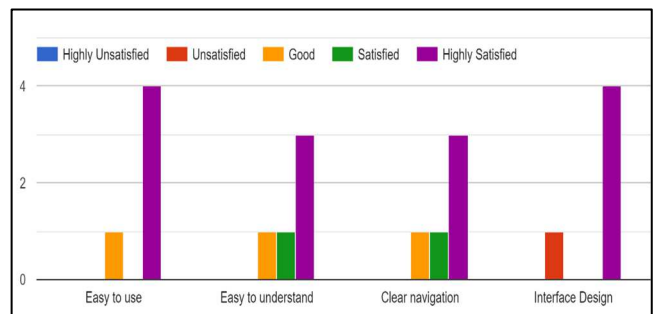

Fig. 9 UAT evaluation result on functionality

Fig. 10 UAT evaluation result on interface design

IV. CONCLUSION

Veterinarian care frequently involves links between other species, and human and animal diagnoses may cross paths. Wellness, averting illness, and rehabilitation have always been top priorities for veterinarians. This obligation includes the welfare of the animals used in food production and the welfare of animal owners, the general public, and the environment [28], [29]. Different pet illnesses could put the animal in risky health conditions. It is important to periodically check on the cat's behavior and symptoms to ensure that the illness does not spread to them [30]. As a result, health is used as the justification for veterinary treatments.

In this paper, a mobile application for diagnosing pet disease based on rule-based reasoning has been proposed. The application aims to help the pets' owners to perform periodic checks on both the health of pets and their behavior. This enables pet owners to identify any illnesses in their animals before they become chronically ill. As a result, this study has established the application development for identifying diseases affecting pet. The suggested application's capabilities are compared to current application programs.

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