Development of an Arabic Pet Adoption System with Hybrid Recommendations

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***Abstract*—Pet adoption platforms often face challenges in effectively matching adopters with suitable pets due to limited personalization and the lack of localized language support. This study presents EWAA, an Arabic-enabled mobile platform for pet adoption in Saudi Arabia that integrates a hybrid recommender system combining content-based and collaborative filtering techniques. The content-based component constructs a user profile from one-hot encoded pet attributes (category, breed, color, and age) of previously liked pets, while the collaborative filtering component identifies similar users through cosine similarity and recommends pets based on their preferences. The two components operate independently in a mixed hybrid configuration, which mitigates the cold-start limitation of collaborative filtering and the over-specialization limitation of content-based filtering. The platform also emphasizes usability, accessibility, and privacy for both adopters and pet owners through a fully Arabic interface and controlled information visibility. The system was evaluated with 20 questionnaire participants and 6 interview participants using User Acceptance Testing (UAT) and Non-Functional Requirements (NFR) testing. Results indicate high levels of user satisfaction, with task completion rates of 100% on 10 of 11 test scenarios, page load times between 1 and 12 seconds, and learning times between 1 and 8 minutes, suggesting that the proposed approach provides a viable foundation for supporting the pet adoption process in Arabic-speaking contexts.**

Keywords*—Recommender systems; pet adoption; mobile applications; collaborative filtering; content-based filtering; user experience

I. Introduction

Pet adoption plays an important role in improving animal welfare while providing companionship and quality-of-life benefits to individuals and families [1]. Despite these benefits, the adoption process remains fragmented in many contexts, relying on physical shelter visits, disconnected platforms, or informal social media channels, which can be inefficient and time-consuming for prospective adopters.

With the growing interest in pet adoption in Saudi Arabia, there is an increasing demand for digital platforms that provide localized and accessible services. However, existing pet adoption platforms exhibit two notable limitations in this context. First, they lack Arabic language support, creating usability barriers for native Arabic speakers. Second, they typically rely on either content-based or collaborative filtering in isolation, each of which suffers from well-known weaknesses: content-based filtering is prone to over-specialization, while collaborative filtering suffers from the cold-start problem [2].

This study presents EWAA, an Arabic-enabled mobile pet adoption platform that integrates a hybrid recommender approach combining content-based and collaborative filtering techniques. The objectives of this work are: first, to design and implement an Arabic-language mobile adoption platform tailored to the Saudi context; second, to integrate a mixed hybrid recommender that mitigates the cold-start and over-specialization limitations of single-method approaches; and third, to evaluate the resulting system through user acceptance and non-functional requirements testing. The significance of the work lies in providing a deployed adoption platform that combines hybrid recommendation with native Arabic language support, addressing both a regional accessibility gap and a methodological gap in prior pet adoption recommenders. The study focuses on cats and dogs, which represent the majority of adoption cases in the target context.

The remainder of this study is organized as follows: Section II reviews related work on pet adoption platforms and recommender approaches. Section III presents the system overview, and Section IV describes the system architecture. Section V details the implementation, and Section VI presents the design of the hybrid recommender. Section VII reports the system evaluation, and Section VIII concludes the study and outlines directions for future work.

II. Related Work

Recommender systems are well established as a means of mitigating information overload and supporting personalized decision-making [3]. They are commonly categorized into content-based, collaborative, and hybrid approaches, with hybrid configurations typically introduced to mitigate the cold-start and over-specialization limitations of the individual methods [2]. Within the pet adoption domain, several lines of work are particularly relevant.

Karani et al. [4] developed a structured dataset and a recommender system to suggest appropriate canine and feline breeds to prospective adopters. Their work provides a foundation for breed-specific recommendations in pet adoption systems. However, the system operates at the level of breeds rather than individual pets, which limits its ability to differentiate between specific animals of the same breed in a real adoption listing, and it does not incorporate user interaction signals such as likes or other implicit feedback.

De Luna et al. [5] compared content-based filtering, collaborative filtering, and k-nearest neighbors for dog breed recommendation, and reported content-based filtering as the best-performing approach.

Montiveles et al. [6] used item-based collaborative filtering with Pearson correlation and k-nearest neighbors to recommend adoptable pets. As a collaborative only approach, the

system is susceptible to the cold-start limitation when new users or pets have limited interaction history, and it does not incorporate content-based signals from pet attributes that could mitigate this gap.

Chaudhari et al. [7] presented a recommender system that uses content-based filtering with cosine similarity metrics to match potential adopters with suitable pets, taking into account various factors such as breed characteristics, adopter lifestyle, and living conditions, and offering a holistic approach to the adoption matching process. However, as a purely content-based method it inherits the well-known over-specialization problem [2]. The approach also does not address the cold-start case in which the active user has not yet liked any pet.

Across these studies, two gaps are relevant to the present work. First, none of the prior systems is evaluated or deployed in an Arabic-language context. Second, with the exception of the comparative evaluation in [5], none of them combines content-based and collaborative signals within a single deployed adoption system, despite the fact that hybrid configurations are a standard remedy for the cold-start and over-specialization limitations identified above. EWAA addresses these gaps by adopting a mixed hybrid configuration [2] over user-supplied pet attributes and interaction data, within a fully Arabic-language mobile platform.

Beyond research prototypes, several deployed platforms support pet adoption services and provide a useful basis for identifying the functional capabilities expected in a mature adoption application. These platforms include PetMatch [8], Petfinder [9], and Pet Adoption [10]. As shown in Table I, a comparison of these platforms highlights their key features and limitations.

The EWAA application addresses several limitations present in existing platforms by offering a user-centric experience tailored to the needs of adopters in Saudi Arabia. One of its key features is Arabic language support, which ensures a seamless navigation experience and improves accessibility for local users. Additionally, EWAA enhances privacy protection by keeping the personal details of pet owners and adopters confidential until an adoption request is accepted, fostering a secure and trustworthy adoption environment. The application also features an intuitive and engaging interface, designed to be visually appealing and user-friendly, which encourages greater interaction and simplifies the pet adoption process. By integrating these improvements, EWAA improves usability, security, and user engagement, providing an optimized platform for pet adoption in the region.

The comparative analysis presented in Table I highlights the strengths of the EWAA system compared to existing pet adoption platforms. Although current systems provide basic features such as browsing, filtering, and pet listing, they lack key features such as Arabic language support, integrated privacy protection, and personalization. In contrast, EWAA combines these capabilities within a single platform by offering accessibility, personalized pet recommendations, and secure adoption workflows. This integration enhances the user experience and supports a more efficient and user-centered pet adoption process.

TABLE I. COMPARISON OF KEY FEATURES BETWEEN EXISTING PET ADOPTION PLATFORMS AND EWAA.

Feature	Pet Adoption	PetMatch	Petfinder	EWAA
User registration	No	No	Yes	Yes
Browse categories	No	No	Yes	Yes
Search and filtering	Yes	Yes	Yes	Yes
Submit request	No	No	Yes	Yes
Add pets	Yes	Yes	Yes	Yes
Recommendations	No	No	Yes	Yes
Favorites	No	Yes	Yes	Yes
Social sharing	Yes	No	Yes	Yes
Arabic support	No	No	No	Yes
Pet care section	No	No	Yes	Yes
User-friendly UI	No	No	Yes	Yes
Privacy protection	No	No	No	Yes

III. SYSTEM OVERVIEW

The proposed system, EWAA, is a mobile-based pet adoption platform designed to streamline and improve the adoption process in Saudi Arabia. It provides a centralized and user-friendly environment that connects potential adopters with pet owners, reducing reliance on traditional methods such as physical shelter visits and informal social media channels.

EWAA provides a unified user model in which a registered user can act as both a pet owner and an adopter depending on the system interaction. This design simplifies user management and enhances flexibility within the platform. Users can browse available pets, apply search and filtering options, and submit adoption requests. Pet owners, on the other hand, can add, update, and manage pet listings, as well as review and respond to adoption requests.

A key feature of the system is the integration of a hybrid recommender system, which combines content-based and collaborative filtering techniques to generate personalized pet suggestions. Recommendations are based on user preferences and interactions, such as selected pet attributes and previously liked pets, improving the likelihood of successful matches between adopters and pets.

In addition to core adoption functionalities, EWAA emphasizes usability and accessibility through its fully Arabic-supported interface, enabling a localized experience for Arabic-speaking users. The system also incorporates privacy mechanisms that ensure user information remains confidential until adoption requests are approved, thereby fostering a secure and trustworthy environment.

Overall, EWAA is designed to improve the efficiency, accessibility, and user experience of the pet adoption process through user-centered recommendation capabilities.

To further illustrate the interaction between users and the system, Fig. 1 presents the main use case diagram of the EWAA application. The diagram highlights the primary functionalities available to both adopters and pet owners, including browsing pets, submitting adoption requests, managing pet listings, and receiving recommendations.

IV. SYSTEM ARCHITECTURE

The system follows a client-server communication model, in which the client sends requests to the server, and the server

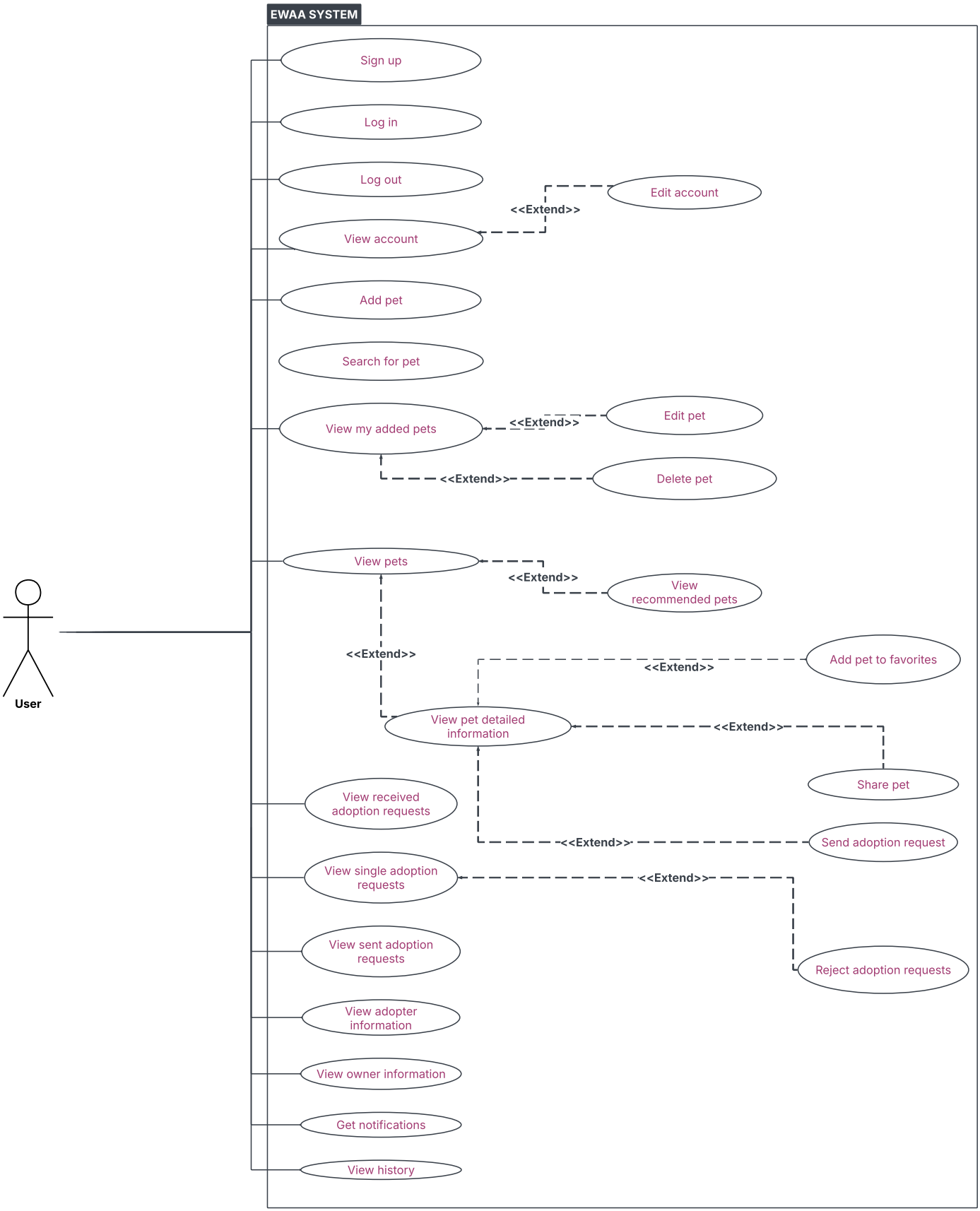


Fig. 1. Use case diagram of the EWAA system.

processes these requests and returns appropriate responses. This architecture supports centralized data management and enables users to access the application from different locations.

Fig. 2 illustrates the overall system architecture of EWAA. The client side is implemented as a mobile application developed using the Flutter framework and the Dart programming language. It provides users with an interactive interface to perform key actions such as browsing pets, submitting adoption requests, managing pet listings, and receiving recommendations. The server side is supported by a cloud-based NoSQL database, allowing efficient data retrieval and scalability.

A dedicated recommender system module, implemented in Python, is integrated into the architecture to generate personalized pet recommendations. The application collects user interaction data, such as preferences and liked pets, and sends this data to the backend database. The recommender module retrieves the stored data, applies the recommendation algorithms described in Section VI, and returns a list of suggested pets to the application, where they are displayed on the user's home page.

V. Implementation

A. Development Methodology

The EWAA system was developed using an agile methodology, specifically the Scrum framework [11], to ensure flexibility and iterative progress throughout the development process. Scrum enables the delivery of system functionalities in incremental stages through short development cycles known as sprints. Each sprint focused on implementing a set of user stories derived from the system requirements.

The development process included key Scrum practices such as sprint planning, progress tracking, and sprint review sessions. These iterative cycles allowed for continuous refinement of system features based on feedback and evolving user requirements. This approach ensured that the system remained aligned with user needs while supporting efficient development and timely delivery.

B. System Implementation

The EWAA system was implemented using a combination of modern development technologies to support scalability, performance, and usability. The mobile application was developed using the Flutter framework and the Dart programming language, providing a responsive and user-friendly interface.

Firebase was used as a Backend-as-a-Service (BaaS) platform, offering functionalities such as user authentication, real-time database management, and cloud storage. The system stores user data, pet information, and interaction records in a cloud-based NoSQL database.

The EWAA system includes a set of core features designed to enhance user experience and streamline the adoption process:

- User Registration and Authentication: Secure account creation, login, and email verification.
- Pet Management: Adding, editing, and managing pet listings with detailed attributes.
- Adoption Requests: Submitting, tracking, accepting, or rejecting adoption requests.
- Recommender System: Personalized suggestions using content-based and collaborative filtering.
- Notifications: Updates on adoption requests and activities related to pets.
- User Interface: Intuitive navigation with filtering and browsing capabilities.
- Privacy Protection: Secure handling of user data and controlled information visibility.

C. Data Collection

To support the recommender system, a data collection process was conducted focusing on cats and dogs, as they represent the most commonly adopted companion animals in Saudi Arabia. Initially, interviews with animal shelters were conducted to identify commonly adopted pet breeds in the region. Based on these findings, key characteristics of each breed were identified, including attributes such as energy level, affection, emotional reactivity, and intelligence.

Since the EWAA system was not deployed at the time of development, real user interaction data were not available. Therefore, a dataset was constructed by collecting information about the pets of real pet owners using an online questionnaire. The data collected included:

- Pet nickname
- Pet gender, age, and color
- Pet type and breed
- Health information (vaccination, sterilization, health profile)
- Personality traits

This dataset was used to initialize the recommender system and support personalized pet suggestions.

The system data structure is modeled, as shown in Fig. 3. The data model captures the main entities of the system — users, pets, adoption requests, and notifications — along with the relationships between them.

Each user can act as both an adopter and a pet owner, enabling them to create and manage pet listings. Adoption requests establish a relationship between users and pets, while interaction data is used to support the recommender system.

VI. Recommender System Design

Recommender systems are information filtering systems that predict user preferences and suggest relevant items. They are widely used in various domains such as e-commerce, healthcare, and online services [3].

In the EWAA system, a hybrid recommender approach is adopted to improve matching accuracy by combining collaborative filtering and content-based filtering techniques. This hybrid approach mitigates the limitations of individual methods by combining user preference modeling with interaction-based similarity.

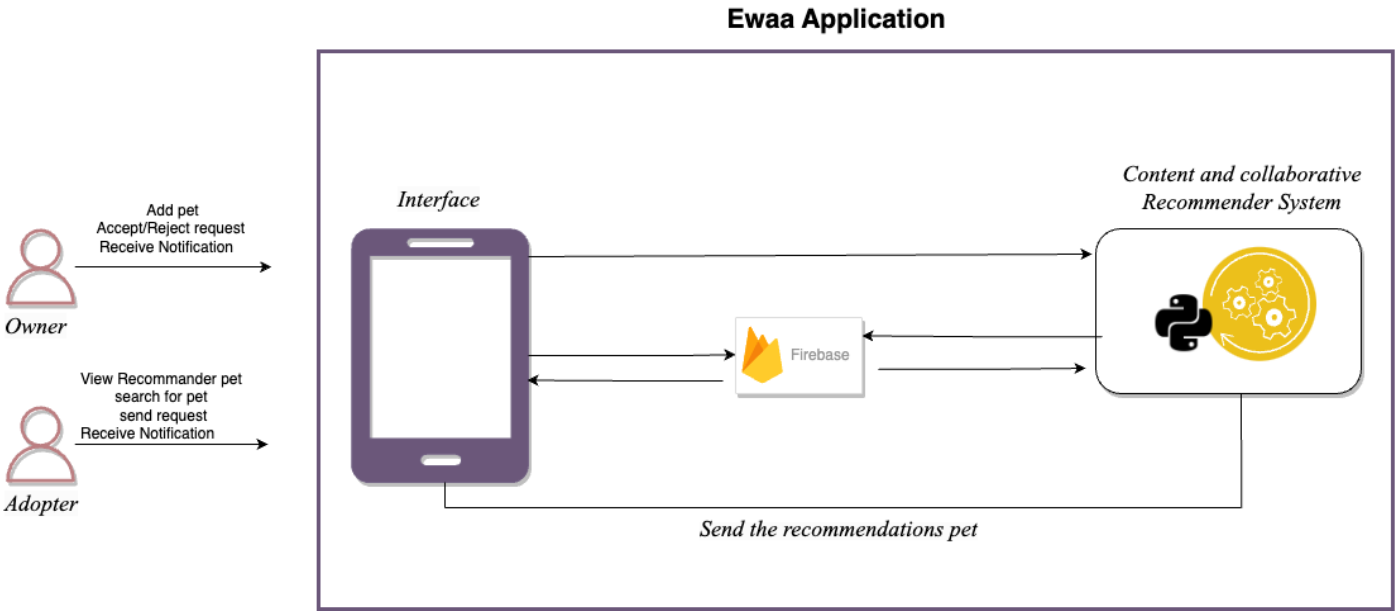


Fig. 2. EWAA system architecture

A. Collaborative Filtering

The collaborative filtering approach identifies users with similar preferences and recommends pets based on their interactions. The system constructs a user–item (likes) matrix R in which each row represents a user and each column represents a pet, with entries indicating whether the user has liked the pet. The similarity between the active user and every other user is computed using the cosine similarity measure:

$$\text{sim}(u, v) = \frac{R_u \cdot R_v}{\|R_u\| \, \|R_v\|} \tag{1}$$

A similarity threshold of $\tau = 0.5$ is applied to retain only sufficiently similar users, from which the top $K = 10$ neighbors are selected. The neighborhood size $K = 10$ and threshold $\tau = 0.5$ follow common practice in memory-based collaborative filtering, where small-to-moderate neighborhoods and mid-range similarity cut-offs are typically reported as a balance between recommendation accuracy and noise from weakly correlated users [3], [12]. Candidate pets already liked by the active user are excluded. The remaining candidates are scored by accumulating the similarity weights of neighbors who liked them, then normalized by the number of contributing neighbors. When the active user has no liked pets or no sufficiently similar users exist, the collaborative filtering component falls back to low-popularity or underexposed pets, to balance visibility and mitigate popularity bias. This choice prioritizes fairness and exposure over accuracy, which is suitable in adoption contexts. The procedure is summarized in Algorithm 1.

This algorithm recommends pets by identifying users with similar preferences and aggregating their interactions to generate relevant suggestions.

Algorithm 1 Collaborative Filtering Recommender

Require: Active user ID u, similarity threshold $\tau = 0.5$, neighborhood size $K = 10$
Ensure: Top 10 recommended pets
Load user–item (likes) matrix R
if u has no liked pets **then**
  return the 10 least-popular pets ▷ cold-start fallback
end if
for each user $v \neq u$ **do**
  $\text{sim}(u, v) \leftarrow \text{cosine}(R_u, R_v)$
end for
$S \leftarrow$ the top K users v with $\text{sim}(u, v) \geq \tau$
if S is empty **then**
  return the 10 least-popular pets ▷ no similar users
end if
Initialize $\text{score}[i] \leftarrow 0$, $\text{count}[i] \leftarrow 0$ for all pets i
for each user $v \in S$ **do**
  for each pet i liked by v and not by u **do**
    $\text{score}[i] \leftarrow \text{score}[i] + \text{sim}(u, v)$
    $\text{count}[i] \leftarrow \text{count}[i] + 1$
  end for
end for
for each pet i with $\text{count}[i] > 0$ **do**
  $\text{score}[i] \leftarrow \text{score}[i]/\text{count}[i]$ ▷ normalization
end for
Sort pets by score in descending order
return the top 10 pets

B. Content-Based Filtering

The content-based approach builds a user profile from the attributes of the pets the user has previously liked, and then recommends candidate pets whose attributes best match that profile. Four attribute groups are considered: category (cat, dog), breed, color, and age group. Each pet is encoded as a one-hot feature vector over the union of all attribute values [13],

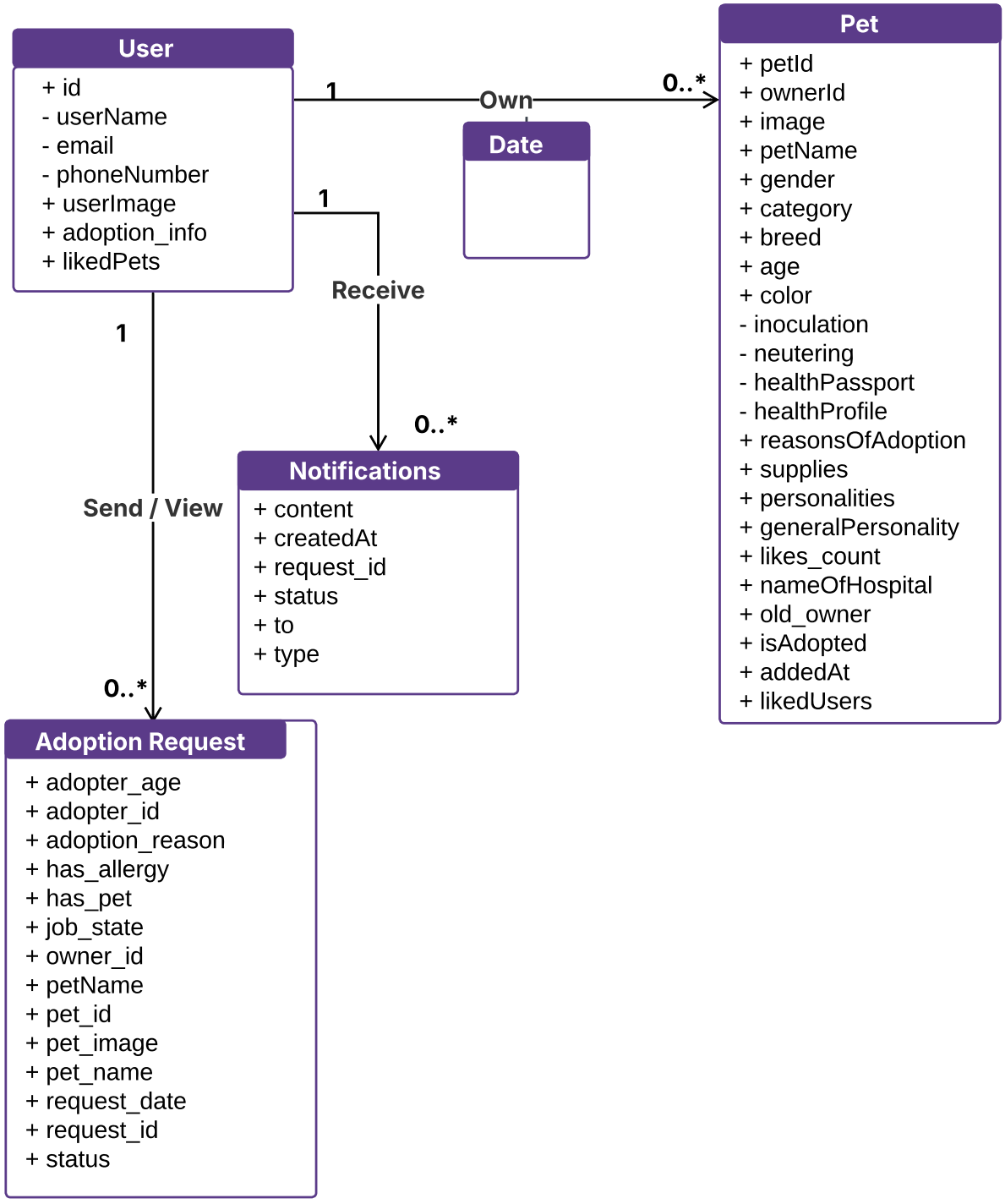


Fig. 3. Data model of the EWAA system.

forming a binary feature matrix F in which rows correspond to pets and columns to feature values.

The user profile p is constructed by averaging the one-hot vectors of the pets the user has liked:

$$p = \frac{1}{|L|} \sum_{\ell \in L} F[\ell] \tag{2}$$

where, L denotes the set of pets liked by the active user. This averaging yields frequency-based attribute weights for the user. For example, if a user has liked three pets with colors

Algorithm 2 Content-Based Recommender

Require: Active user ID u
Ensure: Top 10 recommended pets
$L \leftarrow$ pets liked by u
if L is empty **then**
  return the 10 most-popular pets ▷ cold-start fallback
end if
$F \leftarrow$ one-hot feature matrix over {category, breed, color, age}
Initialize user profile $p \leftarrow \mathbf{0}$
for each pet $\ell \in L$ **do**
  $p \leftarrow p + F[\ell]$ ▷ accumulate one-hot vectors
end for
$p \leftarrow p/|L|$ ▷ attribute-frequency weights
$C \leftarrow$ candidate pets (excluding L)
for each pet $c \in C$ **do**
  $\text{score}[c] \leftarrow \sum_k F[c,k] \cdot p[k]$
end for
Sort C by score in descending order
return the top 10 pets

$\{\text{white}, \text{white}, \text{brown}\}$, the profile assigns a weight of $2/3$ to white and $1/3$ to brown, while all other colors receive a weight of zero. The same principle applies to breed, age, and category, so that the profile captures the relative importance of each attribute value based on the user's observed preferences.

Each candidate pet c (excluding pets already liked by the user) is then scored as the weighted sum of its feature vector with the profile:

$$\text{score}(c) = \sum_k F[c,k] \cdot p[k] \tag{3}$$

Candidates are ranked by their scores and the top 10 pets are returned to the user. The full procedure is presented in Algorithm 2.

This algorithm recommends pets by matching candidate pet attributes to the user's preference profile derived from previously liked pets.

C. Hybrid Integration

The EWAA system implements a *mixed* hybrid configuration [2]: the content-based and collaborative filtering recommenders operate independently, and each produces its own top-10 list. Both lists are then presented to the user on the recommendation page of the application. This design was chosen for two reasons. First, it mitigates the cold-start limitation of collaborative filtering: new users with few or no liked pets still receive useful content-based recommendations. Second, it mitigates the over-specialization limitation of content-based filtering, since the collaborative component can surface pets that do not match the user's explicit attribute preferences but are enjoyed by users with similar overall taste. The two components are integrated through a Flask service that receives the active user's ID from the Flutter front end, executes both recommenders on the data retrieved from the Firebase database, and returns both recommendation lists to the application as JSON.

D. User Interface and Navigation

The EWAA application features a user-friendly interface designed to ensure ease of navigation and accessibility. The Home Page serves as the central hub, allowing users to browse pets, apply filters, and access key features such as adoption requests and user profiles.

Users can navigate through different sections including categories, pet details, notifications, and favorites. The system also supports account management features such as login, registration, and password recovery. Fig. 4 illustrates the application navigation flow.

E. Graphical User Interface

Fig. 5 presents sample screens from the EWAA application, including the login page, home page, filtering interface, and pet listing interface. The graphical user interface was designed to provide a simple and intuitive experience for both adopters and pet owners.

F. UX Guidelines

To ensure usability and accessibility, several user experience guidelines were considered in the design of the EWAA application:

- The system targets a high reliability rate, operating without failure in at least 95% of cases.
- The interface is designed to be intuitive and easy to navigate for users of different technical backgrounds.
- User privacy is protected for both adopters and pet owners.
- The system is scalable and capable of handling a growing number of users.
- Users can learn and use the system efficiently in a short time.

VII. System Testing and Evaluation

Since the EWAA system was not deployed at scale, real user interaction logs were not available for a large-scale offline evaluation of the recommendation algorithms. Instead, the overall system was evaluated using User Acceptance Testing (UAT) and Non-Functional Requirements (NFR) testing with real users, assessing usability, reliability, performance, and overall user satisfaction. Both qualitative and quantitative methods were employed to ensure a comprehensive assessment.

A. User Acceptance Testing

User Acceptance Testing was conducted using two complementary approaches: questionnaires and interviews. A total of 20 participants were involved in the questionnaire-based evaluation.

The demographic profile of the participants was analyzed to ensure a representative evaluation of the system. The majority of the participants were within the 18–25 age group (approximately 60%), followed by users aged 26 to 35 (30%) and a smaller proportion over 35 years (10%). In terms of gender

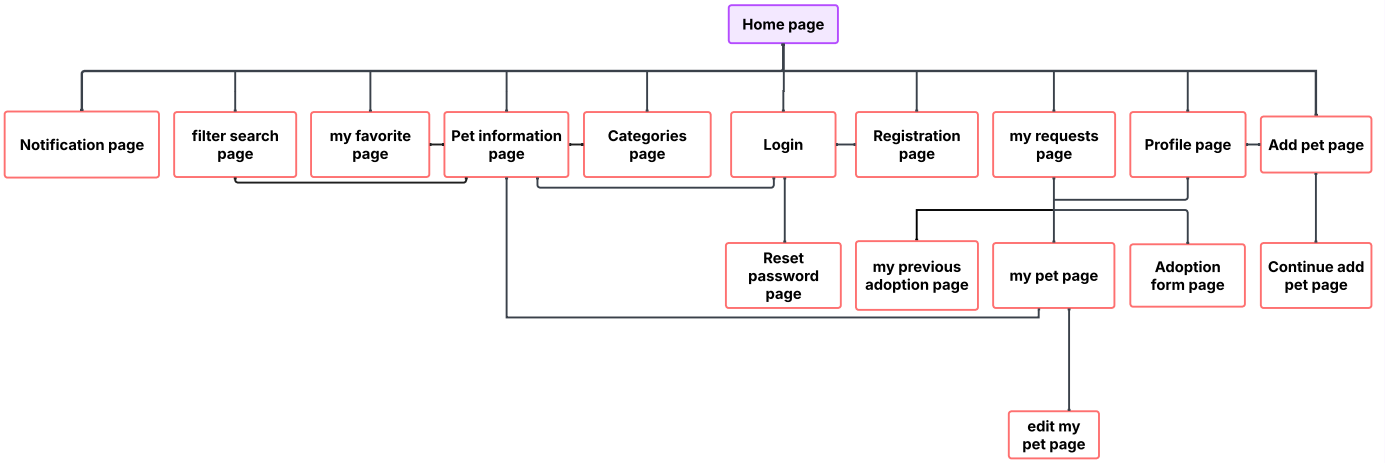
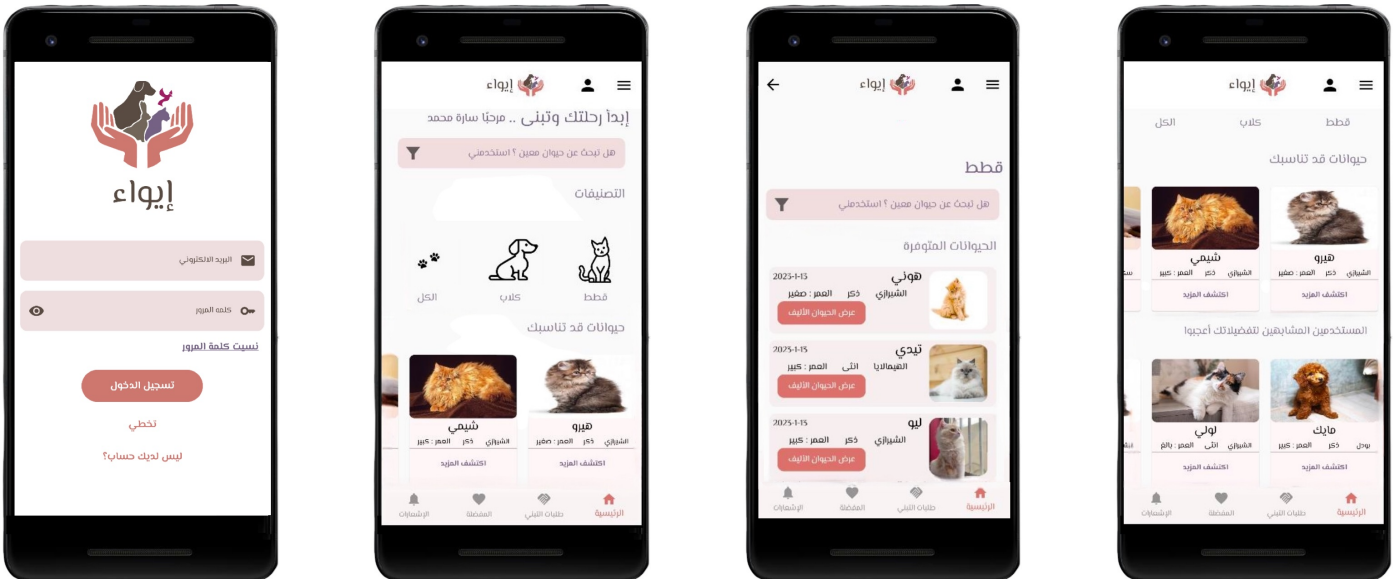


Fig. 4. Application site map



(a) (b) (c) (d)

Fig. 5. EWAA application interface

distribution, the sample included a balanced representation of male (45%) and female (55%) participants. Most participants (65%) reported having owned a pet previously, while 35% had no prior experience. This diversity ensured that the system was evaluated from both experienced and first-time adopter perspectives.

1) Questionnaire-based evaluation: Participants were asked to interact with the application and respond to a set of structured questions that evaluated usability, interface design, and system effectiveness.

The majority of the participants agreed that the application is easy to use, visually appealing, and effective in facilitating the pet adoption process. In addition, users confirmed that the system provides adequate information about pets and supports efficient communication between adopters and pet owners. The summarized results, presented in Table II, indicate a high level of user satisfaction with the EWAA application. Participants reported positive feedback regarding the interface design, usability, and overall functionality. In particular, users agreed that the system is clear, easy to use, and effective in facilitating the pet adoption process. Additionally, the recommender system was well received, with 85% of participants indicating that it helped them identify suitable pets based on their preferences. These findings demonstrate that the application meets user expectations and provides a positive user experience.

2) Interview-based scenario testing: To gain additional insights into system usability, 6 participants took part in interview-based testing. This testing was carried out using 11 predefined scenarios that captured the main functionalities of

TABLE II. SUMMARY OF QUESTIONNAIRE-BASED USER EVALUATION

Evaluation Statement	Agreement (%)	Interpretation
The application interface is attractive	100%	Very Positive
The application is easy to use	95%	Positive
The application is clear and understandable	95%	Positive
The system facilitates the adoption process	90%	Positive
Pet information is sufficient	90%	Positive
User privacy is maintained	100%	Very Positive
The recommender system is helpful	85%	Positive
Overall satisfaction with the application	100%	Very Positive

TABLE III. SCENARIO-BASED USER ACCEPTANCE TESTING RESULTS

No.	Test Scenario	Successful Users (out of 6)	Status
1	User registration	6/6	Pass
2	Add pet for adoption	6/6	Pass
3	Browse pets	6/6	Pass
4	Filter search results	6/6	Pass
5	View pet details	6/6	Pass
6	Add to favorites	6/6	Pass
7	Submit adoption request	6/6	Pass
8	Manage adoption requests	6/6	Pass
9	View notifications	6/6	Pass
10	View recommendations	6/6	Pass
11	View adoption history	3/6	Partial Pass

the application. The scenarios covered tasks such as registering a user, adding pets, filtering search results, handling adoption requests, and using the recommender system.

The results in Table III show that the system achieved a 100% task completion rate for 10 out of 11 test scenarios, indicating a high level of usability and functional correctness. The only scenario that presented difficulty was "viewing the adoption history", where some users were unable to locate the feature due to unclear navigation. This indicates a minor usability issue related to interface design rather than system functionality.

Overall, participants were able to complete core tasks such as signing up, adding pets, filtering searches, sending requests, and interacting with recommendations without any significant issues, demonstrating the system's usability and functional correctness.

B. Non-Functional Requirements Testing

Non-functional testing was conducted to evaluate key quality attributes of the system, including performance, learnability, and reliability. The results are summarized in Table IV.

1) Performance: System performance was evaluated by measuring page loading times during user interaction. All application pages loaded within a range of 1 to 12 seconds, satisfying the predefined requirement of a maximum loading time of 20 seconds. This indicates that the system provides a responsive user experience under the tested conditions.

2) Learnability: Learnability was assessed by measuring the time required for users to understand and complete core functionalities. Participants were able to learn and interact with the system within 1 to 8 minutes, which is well within the acceptable threshold of 10 minutes, suggesting that the system is intuitive for new users.

TABLE IV. NON-FUNCTIONAL REQUIREMENTS TESTING RESULTS

Quality Attribute	Measure	Target	Result
Performance	Page load time	$\leq$ 20 sec	1–12 sec
Learnability	Learning time	$\leq$ 10 min	1–8 min
Reliability	Task success rate	$\geq$ 95%	100%

3) Reliability: Reliability was evaluated by measuring the proportion of functionalities that executed without critical errors. Across the 11 interview-based scenarios, all core functionalities executed without runtime failure; the only observed issue was a navigation visibility problem in one scenario, which is a user-interface concern rather than a functional failure. On this basis, the system met the predefined reliability target of at least 95% task success at the functional level.

C. Discussion

The evaluation results, summarized in Table IV, indicate that the EWAA system meets its usability, performance, and reliability targets. The integration of core adoption functionalities with a personalized recommendation component supports the pet adoption workflow in an Arabic-speaking context.

The only identified limitation in the user-facing evaluation was related to the visibility of the adoption history feature, which can be addressed through minor interface improvements such as clearer navigation or dedicated menu options.

Several limitations of the evaluation should also be acknowledged. First, the sample size (20 questionnaire participants and 6 interview participants) is modest and drawn primarily from a single demographic group (60% aged 18–25), which limits the generalizability of the usability findings to the broader population of potential adopters. Second, participants interacted with the system in controlled testing scenarios rather than through natural long-term use, which may lead to overestimation of reported satisfaction. Third, the questionnaire-based dataset used to bootstrap the recommender reflects owner-reported pet preferences rather than real adoption behavior, which may introduce bias into the learned user profiles once the system is deployed. Finally, the current evaluation focuses on system usability and non-functional qualities rather than the offline accuracy of the recommendation algorithms themselves; the 85% perceived helpfulness reported in Table II is a subjective measure and does not quantify recommendation quality.

A dedicated quantitative evaluation of recommendation quality, using metrics such as precision@N or hit rate on held-out interaction data, is left as future work once sufficient real-user interaction data are collected post-deployment. Overall, the findings indicate that EWAA provides a user-centered platform that supports the pet adoption process, and that addressing the identified navigation issue will further improve the user experience.

VIII. CONCLUSION

This study presented EWAA, an Arabic-enabled mobile platform for pet adoption in Saudi Arabia that integrates a hybrid recommender system combining content-based and collaborative filtering. The content-based component builds a user

profile from one-hot encoded pet attributes of previously liked pets, while the collaborative filtering component identifies similar users through cosine similarity and recommends pets based on their preferences. The two components operate in a mixed hybrid configuration, which mitigates the cold-start limitation of collaborative filtering and the over-specialization limitation of content-based filtering.

The main scientific contribution of this work is the integration of a mixed hybrid recommender, combining one-hot attribute-based content filtering with cosine-similarity collaborative filtering, into an Arabic-language mobile adoption platform, addressing a gap in prior recommender approaches that have neither combined complementary signals within deployed adoption systems nor targeted Arabic-speaking users.

The evaluation results indicate that the system meets its usability, performance, and reliability targets. User Acceptance Testing with 20 questionnaire participants and 6 interview participants confirmed 100% task completion on 10 of 11 test scenarios, with the remaining scenario identifying a minor navigation issue. Non-Functional Requirements testing further verified that page load times (1–12 seconds) and learning times (1–8 minutes) fell well within their predefined targets.

Future work will include an offline evaluation of the recommender component using standard metrics such as hit rate and precision once sufficient real-user interaction data are collected post-deployment. Further directions include exploring alternative recommendation models such as item-based collaborative filtering or matrix factorization, extending the feature set beyond category, breed, color, and age, and adding diversity-aware post-processing. Planned platform extensions include pet health tracking and adoption analytics.

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DECLARATION ON GENERATIVE AI

During the preparation of this manuscript, the author used AI-based language editing tools to assist with grammar, clarity, and formatting. The author reviewed and edited all AI-assisted content and takes full responsibility for the originality, accuracy, and integrity of the final manuscript.

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