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# Feature Model for Pet Health Application Domain using Feature Oriented Domain Analysis

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**Abstract**

According to a survey of Indonesian pet healthcare service users, only 19% of pet health applications are used since the functions offered by the applications are insufficient to meet the users' need. Developing feature model for the pet health application domain is the goal of this research. Using a mixed-methods approach, this research examined nine pet health apps which are available on Google Play and the App Store, observed 30 pet health service consumers through surveys using purposive sampling, and conducted document analyses. The Feature Oriented Domain Analysis (FODA) approach is applied within the Software Product Line Engineering (SPLE) framework. The result of this research is a pet health application domain feature model consisting of five non-functional requirements and 45 functional requirements. With an average assessment score of 96%, domain experts have determined that the feature model implementation in this study is in line with user needs.

## A. Introduction

Currently, pet ownership has become part of 71% of households in Indonesia. Up to 39% of Indonesian pet owners say they have loved and cared for their animals as if they were important members of the family. Because of their attachment, pet owners are now more concerned with providing for their pets' medical requirements in addition to their fundamental needs. According to the TGM Global Pet Care Survey 2023, when it comes to professional pet services, Indonesians most frequently choose veterinarian care [1]. Pet owners have plenty of options at their service in the internet age to assist them access pet care services and gather knowledge. However, as Figure 1 below illustrates, in several countries in 2022, the adoption of mHealth applications will still surpass that of pet-related applications (pet apps).

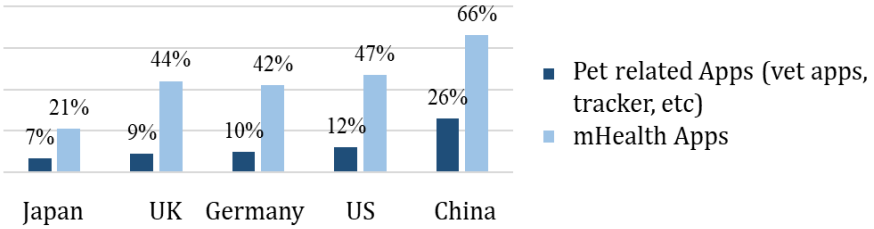


**Figure 1.** Use of Pet Related Apps and mHealth Applications in 2022 (Source: Statista, reprocessed)

Pet owners in Indonesia have a notable tendency to use Internet searches as their main source of high-quality information for pet care, with an amount of 71% selecting for this approach. In addition to adopting digitally, 59% of pet owners use social media as a dependable and trustworthy channel. These numbers demonstrate how much Indonesian pet owners value internet resources [1]. According to a survey of pet healthcare service consumers in Indonesia held in March 2024, just 19% of respondents use pet health applications. This is mostly because users are unaware of these apps and features not meeting user needs, where each was documented at 42.86%.

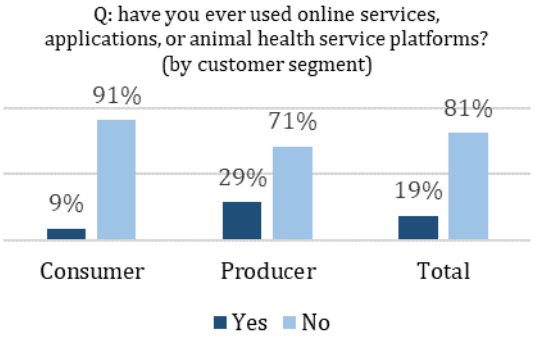


**Figure 2.** Utilization of pet health apps in Indonesia

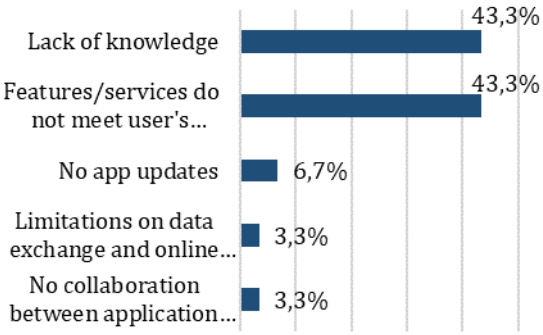


**Figure 3.** Reasons that make user hesitate to use pet health application/platform

A service needs a market that wants it to attract consumers. According to CBInsights' analysis, the second-highest cause of startup failure is a lack of market need, with poor products ranking ninth [2]. This has caused many startups to be unable to survive in their first two years [3]. Meanwhile, based on Future Marketing Insight, the market share for pet care was predicted to achieve Compound Annual Growth Rate (CAGR) of 9.5% from 2023 to 2033, while the market value will reach US$ 5,883.2 million [4]. The pet care industry may promote innovation in businesses, particularly in the pet health services sector, as it should ideally not only rely on offline services but also increase in tandem with the usage of digital services.

Meanwhile, veterinarian clinics and hospitals can use customized software that is made to fit their demands as pet health service providers. While the business models of pet health service companies are similar, each has distinct qualities and needs. Multi-sided platform startups will create an ecosystem centered on maximizing gains by enabling transactions between two or more interdependent organizations. Trade takes place in the pet health sector between client segments, namely pet owners as customers and veterinarians and other service providers as producers [3]. In terms of pet-related app development, a clone-and-own approach can also be considered. However, this requires technical assistance to modify or adapt the software to the needs of the veterinary hospital or clinic. The cost of adopting cloned software will be as great as the cost of procuring unique new software. These expenses are caused by necessary adjustments to meet needs. This clone-and-own method produces software that is different from the cloned software. Cloned software maintenance will also be difficult for developers [5].

In connection with this, Software Product Line Engineering (SPLE) offers developers the capability to produce many different pieces of software that have the same basic requirements with specified variability. This approach aims to reduce the complexity of maintaining several similar software products [6]. SPLE consists of two development processes: domain engineering and application engineering. Domain engineering defines domain artifacts as platforms consisting of reusable artifacts. Reusable artifacts encompass the commonality and variability of all types of software products. The second process is application engineering, to obtain application artifacts from domain artifacts based on user needs. Specific requirements may be implemented in application artifacts that differ from domain artifacts. By using a reusable platform, SPLE can reduce the development costs of many software products while meeting individual customer needs [5].

The objective of this research is to obtain an application feature model in the pet health domain using the Feature Oriented Domain Analysis (FODA) method. This research was conducted on pet health applications used by users in Indonesia, which were available on Google Play and the App Store during the period and could be downloaded from March to April 2024. The object of this research is for a group of pet health service users to explore the necessary innovations. The result of this research is a feature model that can be used in software development in the pet health application domain.

## B. Research Method

Based on a systematic literature review, six relevant previous studies were reviewed. These studies provide important contributions to the development of software product line engineering (SPLE) and focus on feature modeling and variation analysis. Research [5] explored the integration of requirements from multiple single products in the SPLE feature model, while [7] analyzed mHealth application features based on developer descriptions and user reviews, which are relevant for feature modeling in pet health applications. Meanwhile, [8] introduced a formal framework for the Cardinality-Based Feature Model (CBFM), which allows granular control through determining feature cardinality. This research was expanded by [9] with local features. Research [10] provides a systematic review of the SPL and variation model literature, identifying trends and research gaps. FODA has been extensively used and validated in various domains, providing a proven methodology for feature modeling. Its established track record can instill confidence in stakeholders and ensure a more predictable and reliable feature modeling process [11] [12].

### Feature Oriented Domain Analysis (FODA)

The most common method for modeling product lines is feature modeling. Feature modeling is an important approach to capture commonality and variability in a series of systems and product lines [13]. Features are arranged in a feature diagram. A feature diagram is a feature tree with roots representing a concept (for example, a software system). A feature model called Feature Oriented Domain Analysis (FODA) is used to represent SPLs. Using this paradigm, we may define products in an SPL by visually representing attributes and their relationships. A FODA Diagram shows the graphical organization of a FODA model. A FODA Diagram is essentially a clear-cut graph with key feature information that is easy to read. The set of arcs and the set of nodes are the two distinct components of this diagram. The former embodies the SPL's characteristics. The latter stands for the SPL's limitations and relationships [14].

The research method used in this research is a mixed method. Quantitative research examines relationships between variables, which are measured numerically and analyzed using various statistical techniques [15]. Meanwhile, mixed-methods research is a research approach that combines elements from qualitative and quantitative research in one study to provide a more comprehensive understanding of the phenomenon being studied. This method utilizes the strengths of each approach to complement each other and provide a more holistic perspective [16]. This research approach is action research conducted on nine pet health applications available on Google Play and the App Store to develop feature models in the pet health application domain.

### Domain Analysis

Domain analysis for animal health service applications is outlined in several components, namely domain definition, domain lexicon, concept model, and feature model [17]. The pet health application domain in this research includes various functions targeted at managing the health and welfare of pets. Its primary goal is to provide pet owners, veterinarians, and pet service providers with tools to

track, manage, and improve pet health through a variety of services. A domain lexicon defines the domain vocabulary. The domain lexicon used in this research is user profile management, animal profile management, history recording, appointment management, veterinary services, marketplaces, directories, and additional pet care services.

Next, context analysis is used to determine the scope of the domain in producing domain products, or the boundaries of the domain to be analyzed [17]. In the context analysis phase, an analysis is conducted on the relationship between the candidate domain and elements outside the domain and an evaluation of the relationship of variability with external conditions (for example, different applications that use the domain and their data requirements, different operating environments, etc.). The results of the context analysis are documented in the context model. This context model defines domain boundaries, namely the scope of domain modeling that follows context analysis [11]. The context diagram for the Pet Health Application Domain can be seen in Figure 4.

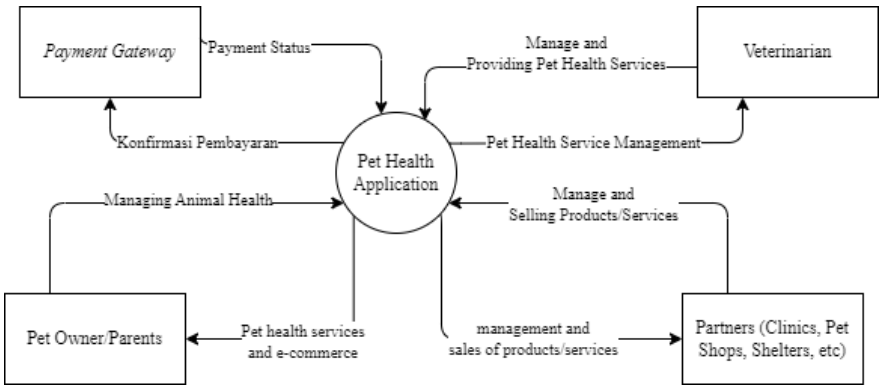


**Figure 4.** Pet Health Application Domain Context Diagram

In Figure 4, entities in the pet health domain consist of pet owners, veterinarians, and partners (clinics, pet shops, shelters, insurance providers, etc.). Pet owners interact with the system to manage their pet health. Veterinarians use systems to manage and provide animal health services. Meanwhile, partners use a system to manage and sell products and/or services related to pets. Meanwhile, the payment gateway entity is used to facilitate the online payment process.

**Domain Requirement Analysis**

Domain Requirements Analysis defines and validates functional and nonfunctional requirements for systems in the domain [18]. In general, the main business processes in pet health services include several important stages, which can be grouped into pre-examination, examination, and post-examination [19]. Requirements are conditions or abilities needed by users to solve a problem or achieve certain goals. In domain requirements engineering, requirements can be combined from different sources, such as stakeholders, existing products, failure reports, or competing products, to determine common and variable requirements

for a product line. These sources are used to detail features determined by product management [6]. For this reason, in determining the requirements analysis for applications in the pet health domain, researchers also examined types of animal health services through document analysis based on the Regulation of the Minister of Agriculture of the Republic of Indonesia (Permentan) Number 3 of 2019 and SNI 9184:2023 Animal Health Services. Even though these two documents do not regulate pet health applications, the need for physical animal health services can be taken into consideration when mapping feature requirements for the application. Minister of Agriculture Regulation Number 3 of 2019 regulates the actions carried out by veterinary medical personnel (veterinarians and specialist veterinarians) in carrying out veterinary medical services. Meanwhile, in SNI 9184:2023 Animal Health Services, it is known that pet shop service facilities and healthy/medical bathrooms (grooming) are optional services that, if available, provide added value for both animal hospitals, animal clinics, and independent veterinary practices.

Based on these two documents, it is known that the functional requirements for animal health services or veterinary medical services include:

1. Providing diagnosis and prognosis for animal diseases.
2. Therapeutic transactional actions, namely actions that include promotive, preventive, curative, rehabilitative, and reproductive medical services. A therapeutic transaction is an agreement between a veterinarian and a client that gives the veterinarian authority to carry out health service activities for patients based on their expertise and skills.
3. Animal health consultations and client or public education regarding animal health and the environment.

Requirements artifacts are products of the requirements engineering process, determined using natural language and/or requirements models, including textual requirements, objectives, features, use cases, and scenarios [6]. Based on requirements mapping for 9 pet health applications, the Ministry of Agriculture document Number 3 of 2019 and SNI 9184:2023, as well as user surveys, 45 functional requirements and 5 nonfunctional requirements were obtained, as shown in the Table 1 and Table 2. This research uses the coding scheme in research [7] to analyze features as requirement artifacts from functional requirements. Grounded theory is used to identify, conceptualize, and re-categorize application features into three feature levels, namely: feature groups (highest level), feature types (second level), and individual features (lowest level), as shown in the Table 3.

**Table 1.** Pet Health Application Domain Functional Requirements

| No | Functional Requirements | Data Source | | |
|---|---|---|---|---|
| | | Application Feature | SNI 9184: 2023 | User Survey |
| 1 | Register and manage user profiles for user types such as "client" or pet owner. | ✓ | - | - |
| 2 | Register and manage user profiles for user type="veterinarian"". | ✓ | - | - |
| 3 | Register and manage user profiles, for user type = "Partner," | ✓ | - | - |

| No | Functional Requirements | Data Source | | |
|---|---|---|---|---|
| | | Application Feature | SNI 9184: 2023 | User Survey |
| | including veterinary clinics, shops, pet shops, and animal shelters. | | | |
| 4 | Manage animal profiles or identities. | ✓ | - | ✓ |
| 5 | Record and display birthday/adoption day reminders | ✓ | - | - |
| 6 | Record and display vaccine reminders. | ✓ | - | ✓ |
| 7 | Record and display control reminders. | - | - | ✓ |
| 8 | Record and display routine medication reminders. | ✓ | - | ✓ |
| 9 | Perform and display transaction history recording. | ✓ | - | - |
| 10 | Record and display appointment or consultation history. | ✓ | - | - |
| 11 | Perform and display medical record recording (integrated). | ✓ | ✓ | ✓ |
| 12 | Carry out and display inpatient records (drug use and procedures). | - | - | ✓ |
| 13 | Perform and display appointment recording by type of visit to the clinic. | ✓ | - | ✓ |
| 14 | Perform and display appointment recording with home visit types | ✓ | - | - |
| 15 | Carry out and display appointment recording with pick-up and drop-off facilities. | ✓ | - | - |
| 16 | Online consultations (24 hours) | ✓ | - | ✓ |
| 17 | Carry out joint consultations between doctors/veterinary clinics in Indonesia and other doctors/veterinary clinics. | ✓ | - | - |
| 18 | Monitor consultation schedules. | ✓ | - | - |
| 19 | Administer prescriptions or medications (especially routine medications). | ✓ | ✓ | - |
| 20 | Provide services or issue reference letters. | - | ✓ | ✓ |
| 21 | Issue certificates (death, reproductive status, health). | - | ✓ | - |
| 22 | Shopping and product delivery (e-commerce). | ✓ | ✓ | - |
| 23 | Shopping and drug delivery. | ✓ | ✓ | ✓ |
| 24 | Provide product consultations and recommendations. | ✓ | - | - |
| 25 | Manage orders. | ✓ | - | - |
| 26 | Manage products and stock. | ✓ | - | - |
| 27 | Manage balances. | ✓ | - | - |
| 28 | Perform and display search results for the nearest pet shop or animal clinic. | ✓ | - | - |
| 29 | Perform and display search results for 24-hour veterinary clinics or those that have certain facilities (for example, an emergency room, ultrasound, radiology, lab, or infectious inpatient). | ✓ | - | ✓ |
| 30 | Process and display bills. | ✓ | - | - |
| 31 | Process and display payments. | ✓ | - | ✓ |
| 32 | Process and display the balance or money withdrawal status. | ✓ | - | - |
| 33 | Order additional services in the form of grooming. | ✓ | - | - |
| 34 | Order additional services in the form of pet training. | ✓ | - | - |
| 35 | Order additional services in the form of a pet sitter or walker. | ✓ | - | - |
| 36 | Order additional services in the form of transportation, a taxi, or an ambulance. | ✓ | - | ✓ |
| 37 | Order additional services in the form of hotel or pet care. | ✓ | - | ✓ |

| No | Functional Requirements | Data Source | | |
|---|---|---|---|---|
| | | Application Feature | SNI 9184: 2023 | User Survey |
| 38 | Order additional services in the form of cage cleaning services. | ✓ | - | - |
| 39 | Order additional services in the form of dating. | ✓ | - | - |
| 40 | Order additional services in the form of insurance. | ✓ | - | - |
| 41 | Order additional services in the form of membership (membership, referral, or loyalty program). | ✓ | - | - |
| 42 | Manage and display health articles. | ✓ | ✓ | ✓ |
| 43 | Manage and present discussions and education. | ✓ | ✓ | ✓ |
| 44 | Manage and display donation status. | ✓ | - | - |
| 45 | Manage and display adoption status. | ✓ | - | - |

**Table 2.** Pet Health Application Domain Non-Functional Requirements

| No | Criteria | Non-Functional Requirements | Data Source | | |
|---|---|---|---|---|---|
| | | | Application Feature | SNI 9184: 2023 | User Survey |
| 1 | *Security* | Encrypt the storage and transmission of payments and data (e.g., medical records). | ✓ | - | ✓ |
| 2 | *Security* | Group and display information based on access rights. | ✓ | - | ✓ |
| 3 | *Scalability* | Store medical record data in various formats (text, photos, and videos) without affecting application performance. | - | - | ✓ |
| 4 | *Portability* | Run on iOS and Android devices | ✓ | - | - |
| 5 | *Portability* | Provide data migration mechanism | - | - | ✓ |

**Table 3.** Mapping Groups and Feature Types in the Pet Health Application

| Feature Code | Feature Group | Feature Code | Individual Feature |
|---|---|---|---|
| User Management (UM) | Registration and User Profile Management (UM-P) | UM-P-1 | Client Profile |
| | | UM-P-2 | Veterinarian Profile |
| | | UM-P-3 | Partner Profile |
| | Pet Profile Management (UM-H) | UM-H-1 | Pet Profile or Identity |
| | | UM-H-2 | Birthday or Adoption Day Reminder |
| | | UM-H-3 | Vaccination Reminder |
| | | UM-H-4 | Check-up Reminder |
| | | UM-H-5 | Medication Reminder |
| | Record Management (UM-R) | UM-R-1 | Transaction History |
| | | UM-R-2 | Appointment/Consultation Record |
| | | UM-R-3 | Integrated Medical Record |
| | | UM-R-4 | Inpatient Record (Medication and Medical Treatment) |
| Pet Health-care (PH) | Reservation/Appointment Management (PH-B) | PH-B-1 | Clinic Visit Appointment |
| | | PH-B-2 | House Visit Appointment |
| | | PH-B-3 | Shuttle Service Reservation |
| | Veterinary Consultation (PH-C) | PH-C-1 | Online Consultation (24 hrs) |
| | | PH-C-2 | Collaboration Consultation |

| Feature Code | Feature Group | Feature Code | Individual Feature |
|---|---|---|---|
| | | PH-C-3 | Schedule Monitoring |
| | | PH-C-4 | Prescription |
| | | PH-C-5 | Referrence Letter |
| | | PH-C-6 | Certificate (Birth, Reproduction Status, Death) |
| | Marketplace (PH-M) | PH-M-1 | Product Purchase and Delivery |
| | | PH-M-2 | Medication Purchase and Delivery |
| | | PH-M-3 | Product Recommendation/Consultation |
| | | PH-M-4 | Order Management |
| | | PH-M-5 | Product and Inventory Management |
| | | PH-M-6 | Balance Management |
| | Directory (PH-D) | PH-D-1 | Search: Nearest Pet Shop/Vet Clinic |
| | | PH-D-2 | Search: Vet Clinic with Specific Facilities |
| | Payment Management (PH-P) | PH-P-1 | Bill |
| | | PH-P-2 | Payment |
| | | PH-P-3 | Withdrawal |
| | Additional Services (PH-A) | PH-A-1 | Grooming |
| | | PH-A-2 | Training |
| | | PH-A-3 | Pets Sitter/Walker |
| | | PH-A-4 | Transportation, Taxi, or Ambulance |
| | | PH-A-5 | Boarding/Pet Hotel |
| | | PH-A-6 | Cage Cleaning Services |
| | | PH-A-7 | Dating |
| | | PH-A-8 | Insurance |
| | | PH-A-9 | Membership, Referral or Loyality Program |
| Information Sharing and Community (SC) | Education and Community (SC-E) | SC-E-1 | Health-care Article |
| | | SC-E-2 | Forum Discussion |
| | | SC-E-3 | Donation |
| | | SC-E-4 | Adoption |

## Commonality and Variability analysis

Commonality and variability analysis can be obtained, among other methods, through a priority-based analysis. Commonality and variability analysis based on priorities is based on a set of requirements, where each requirement is assessed by different stakeholders as stated by a certain scheme. General requirements include at least a set of basic requirements that must be met by every application for the domain. Another indicator of commonality is that requirements have a high priority for a large group of customers, and other customers do not reject them. Meanwhile, requirements that have high priority for some customers but low priority for other customers are candidates for variability [6].

The Analytic Hierarchy Process (AHP) is used to determine the weight between feature appearance frequency, added value (compliance with terms), and user needs, with results on a pairwise comparison matrix, a normalized matrix, calculations on priorities, a priority weight vector, consistency ratio, and consistency index as follows:

**Table 4.** Mapping Groups and Feature Types in the Pets Health Application

| Source | Pairwise Comparison Matrix (Average Value) | Normalized Matrix | Priority Weight | Priority Weight |
|---|---|---|---|---|

| | FA | DD | SP | Total | FA | DD | SP | Total | Value | Pct | Vector |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **FA** | 1 | 2 | 1 | 4,00 | 0,25 | 0,77 | 0,33 | 1,35 | 0,45 | 42% | 3,00 |
| **DD** | 0,61 | 1 | 1 | 2,61 | 0,15 | 0,38 | 0,33 | 0,87 | 0,29 | 27% | 3,06 |
| **SP** | 1 | 1 | 1 | 3,00 | 0,25 | 0,38 | 0,33 | 0,97 | 0,32 | 30% | 3,30 |

where:
FA=Frequency of Appearance in Applications,
DD=Compliance with Terms (Added Value), and
SP=User Needs based on surveys.

Equation (1) [20] shows the average consistency value (λmax), which obtained with the following results:

$$\lambda max = \frac{\sum Priority\ Weight\ Vector}{n} \quad (1)$$

$$\lambda max = \frac{3{,}00 + 3{,}06 + 3{,}30}{3} = \frac{9{,}36}{3} = 3{,}12$$

Once the assessment is complete, it's crucial to verify its consistency. In AHP analysis, some inconsistencies are permitted because the numerical values are derived from individual subjective judgments, so they are impossible to avoid [21]. The consistency index (CI) is obtained using Equation (2).

$$CI = \frac{\lambda - n}{n-1} \quad (2)$$

$$CI = \frac{3{,}12 - 3}{3 - 1} = \frac{0{,}12}{2} = 0{,}06$$

Next, to calculate how much inconsistency is acceptable, this is done through the consistency ratio (CR), which compares the consistency index (CI) with the consistency index from the Random Consistency Index (RI) matrix as shown in Equation (3) [20].

$$CR = \frac{CI}{RI} \quad (3)$$

$$CR = \frac{0{,}06}{0{,}58} \approx 0{,}10$$

In this research, a CR value of 0.1 was obtained; therefore, the comparison was considered consistent, and the solution could be considered optimal. For this reason, the weight for each data source refers to the priority weight percentage value, which is displayed in Table 2.

After identifying the features and mapping the application product, as well as obtaining priority weights for each criterion, the next stage is to identify the commonality and variability of the features. The total criteria value uses the Equation (4):

$$Total\ Criteria\ Value = \sum_{i=1}^{3} (Fi\ x\ Priority\ Weight\ Percentage\ i) \quad (4)$$

Where:
- *Fi* is the value for the *i* criterion.
- Priority Weight Percentage *i* is the priority weight percentage value for the *i* criterion.
- *i* is an index that goes from 1 to 3, because there are 3 criteria.

In CBFM, commonality and variability tables can help identify commonality and variability among various products or services in the pet health application

domain. In this research, feature categories can be determined as commonality or variability based on the number of criteria values with the following priority-based value grouping guidelines:

**Table 5.** Commonality and Variability Categories

| Maximum Value | Percentage of Total Criteria | Range Value | Categories |
|---|---|---|---|
| *nMax* = 4,7 | ≥ 75% from *nMax* | ≥ 3,6 | *High Commonality* |
| | ≥ 50% s.d. <75% from *nMax* | ≥ 2,4 and < 3,6 | *Moderate Commonality* |
| | ≥ 25% s.d. <50% from *nMax* | ≥ 1,2 and < 2,4 | *Moderate Variability* |
| | < 25% from *nMax* | < 1,2 | *High Variability* |

The results of the commonality and variability analysis show that the variety of features in the pet health application domain is very high, consisting of 26 features with high variability and 7 features with moderate variability. Meanwhile, there are only 3 features with high commonality and 9 features with moderate commonality.

## Analysis of Mandatory and Optional Features

Features that have a high commonality value are strong candidates for consideration as mandatory features, considering that they have been influenced by various factors other than application commonality, including added value and users' needs. Features that have low scores in certain categories are identified as variable features or become optional features. Optional features are those that can be selected or not [22].

**Table 6.** Application Requirement Matrix

| Feature Code | Individual Feature | Customer Segment | Feature Category |
|---|---|---|---|
| **Feature Group: User Management (UM)** | | | |
| **Feature Type: Registration and User Profile Management (UM-P)** | | | |
| UM-P-1 | Client Profile | C | Mandatory |
| UM-P-2 | Veterinarian Profile | P | Mandatory |
| UM-P-3 | Partner Profile | P | Mandatory |
| **Feature Type: Pet Profile Management (UM-H)** | | | |
| UM-H-1 | Pet Profile or Identity | C | Mandatory |
| UM-H-2 | Birthday or Adoption Day Reminder | C | Optional |
| UM-H-3 | Vaccination Reminder | C & P | Mandatory |
| UM-H-4 | Check-up Reminder | C & P | Optional |
| UM-H-5 | Medication Reminder | C & P | Optional |
| **Feature Type: Record Management (UM-R)** | | | |
| UM-R-1 | Transaction History | C & P | Mandatory |
| UM-R-2 | Appointment/ Consultation Record | C & P | Optional |
| UM-R-3 | Integrated Medical Record | C & P | Mandatory |
| UM-R-4 | Inpatient Record (Medication and Medical Treatment) | P | Optional |
| **Feature Group: Pet Health-care (PH)** | | | |
| **Feature Type: Reservation/Appointment Management (PH-B)** | | | |
| PH-B-1 | Clinic Visit Appointment | C & P | Mandatory |
| PH-B-2 | House Visit Appointment | C & P | Optional |
| PH-B-3 | Shuttle Service Reservation | C & P | Optional |

| Feature Code | Individual Feature | Customer Segment | Feature Category |
|---|---|---|---|
| **Feature Type: Veterinary Consultation (PH-C)** | | | |
| PH-C-1 | Online Consultation (24 hrs) | C & P | Mandatory |
| PH-C-2 | Collaboration Consultation | C & P | Optional |
| PH-C-3 | Schedule Monitoring | P | Optional |
| PH-C-4 | Prescription | P | Optional |
| PH-C-5 | Reference Letter | C & P | Optional |
| PH-C-6 | Certificate (Birth, Reproduction Status, Death) | C & P | Optional |
| **Feature Type: Marketplace (PH-M)** | | | |
| PH-M-1 | Product Purchase and Delivery | C & P | Optional |
| PH-M-2 | Medication Purchase and Delivery | C & P | Mandatory |
| PH-M-3 | Product Recommendation/ Consultation | C & P | Optional |
| PH-M-4 | Order Management | P | Optional |
| PH-M-5 | Product and Inventory Management | P | Optional |
| PH-M-6 | Balance Management | P | Optional |
| **Feature Type: Directory (PH-D)** | | | |
| PH-D-1 | Search: Nearest Pet Shop/Vet Clinic | C | Optional |
| PH-D-2 | Search: Vet Clinic with Specific Facilities | C | Optional |
| **Feature Type: Payment Management (PH-P)** | | | |
| PH-P-1 | Bill | C & P | Optional |
| PH-P-2 | Payment | C & P | Mandatory |
| PH-P-3 | Withdrawal | P | Optional |
| **Feature Type: Additional Services (PH-A)** | | | |
| PH-A-1 | Grooming | C & P | Optional |
| PH-A-2 | Training | C & P | Optional |
| PH-A-3 | Pets Sitter/Walker | C & P | Optional |
| PH-A-4 | Transportation, Taxi, or Ambulance | C & P | Optional |
| PH-A-5 | Boarding/Pet Hotel | C & P | Optional |
| PH-A-6 | Cage Cleaning Services | C & P | Optional |
| PH-A-7 | Dating | P | Optional |
| PH-A-8 | Insurance | C | Optional |
| PH-A-9 | Membership, Referral or Loyality Program | C | Optional |
| **Feature Group: Information Sharing and Community (SC)** | | | |
| **Feature Type: Education and Community (SC-E)** | | | |
| SC-E-1 | Health-care Article | C & P | Mandatory |
| SC-E-2 | Forum Discussion | C & P | Optional |
| SC-E-3 | Donation | C & P | Optional |
| SC-E-4 | Adoption | C & P | Optional |

Where: C=Consumer, and P=Producer.

## C. Result and Discussion

This chapter will discuss the results of the research conducted on the feature model for the pet health application domain.

### Feature Diagram

Based on the Mandatory and Optional Feature Table obtained through analysis of mandatory and optional features, feature diagrams are created using the FODA method.

### Domain Expert Validation

Based on the feature diagram that has been prepared, an evaluation is carried out through validation by a domain expert to ensure that the feature model is in accordance with the practical needs and expectations of users in the specific application domain. The domain model is expected to capture all the domain information necessary for the correct and clear development of the envisioned software system. However, due to the high likelihood of misunderstandings and misrepresentations often associated with complex systems, domain experts are expected to validate the domain model before development resources are committed. Domain expert validation is used to ensure that the output of requirements analysis represents a correct and complete description of the envisioned system from their point of view [23]. Domain experts who have been consulted during the analysis should not be selected for validation to avoid possible bias [11].

The domain experts review feature models and provide feedback on the relevance and accuracy of identified features. There are 5 domain experts from each customer segment, consisting of 3 experts from producers and 2 experts from consumers. Based on domain expert validation, it is known that as many as 71% of features are appropriate, and there are 29% of features that need refinement from optional to mandatory, of which there is 1 feature with an adjustment from "Medication Reminder" to "Medication Monitoring" to accommodate the requirement of drug administration monitoring more completely, as well as 1 feature that was originally only for the producer segment becoming available for the consumer segment. The feature diagram after refinement is shown with a yellow highlighted box, as can be seen in Figure 5. The diagrams for six features are explained in Figures 6 to 11 below:

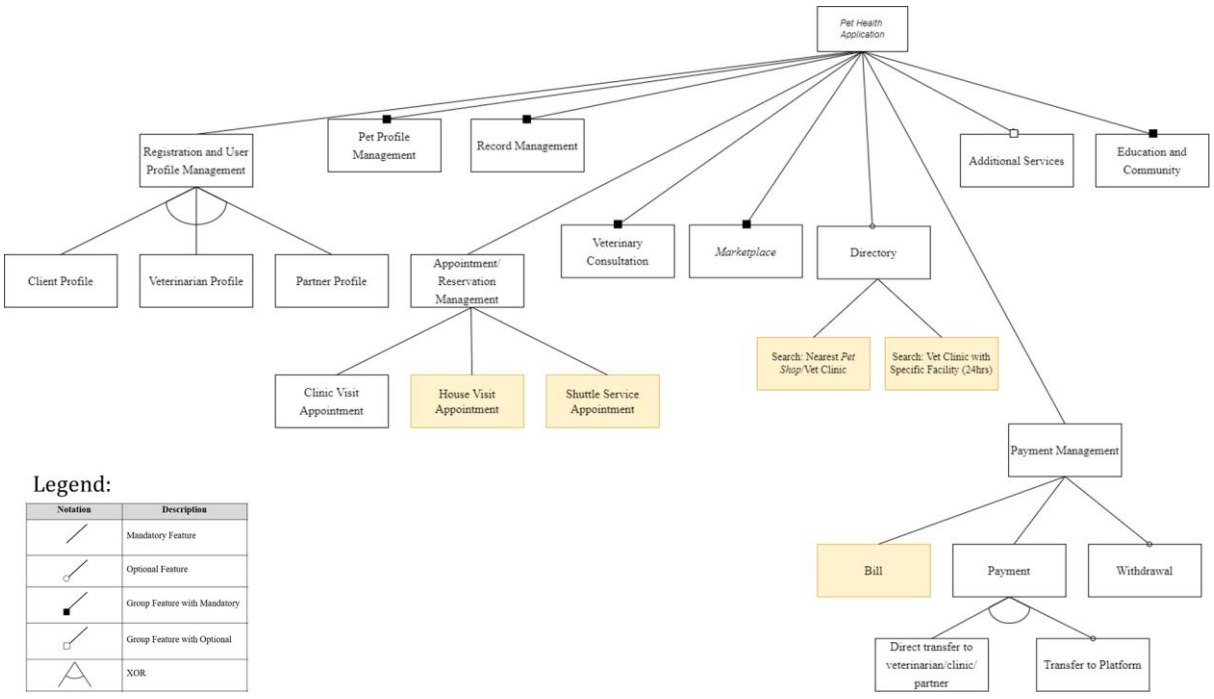


**Figure 5**. Feature Diagram Pet Health Application Domain

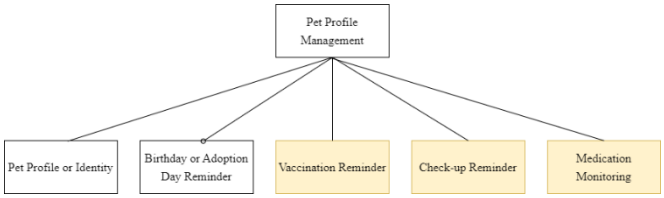


**Figure 6**. Feature Diagram of "Pet Profile Management" Feature

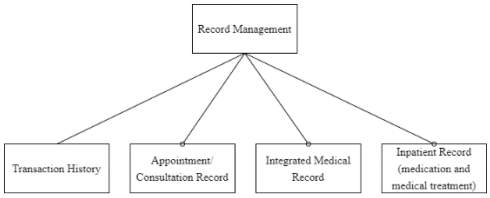


**Figure 7**. Feature Diagram of "Record Management" Feature

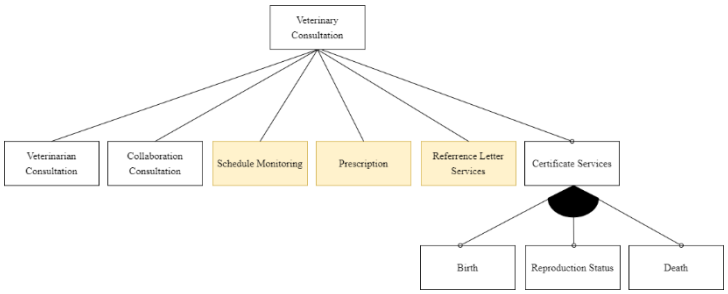


**Figure 8**. Feature Diagram of "Veterinary Consultation" Feature

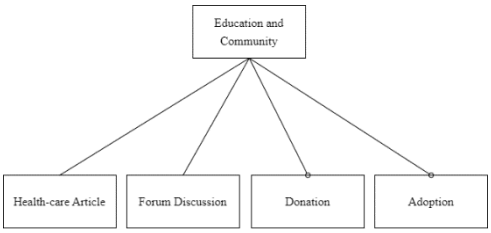


**Figure 9.** Feature Diagram of "Education and Community" Feature

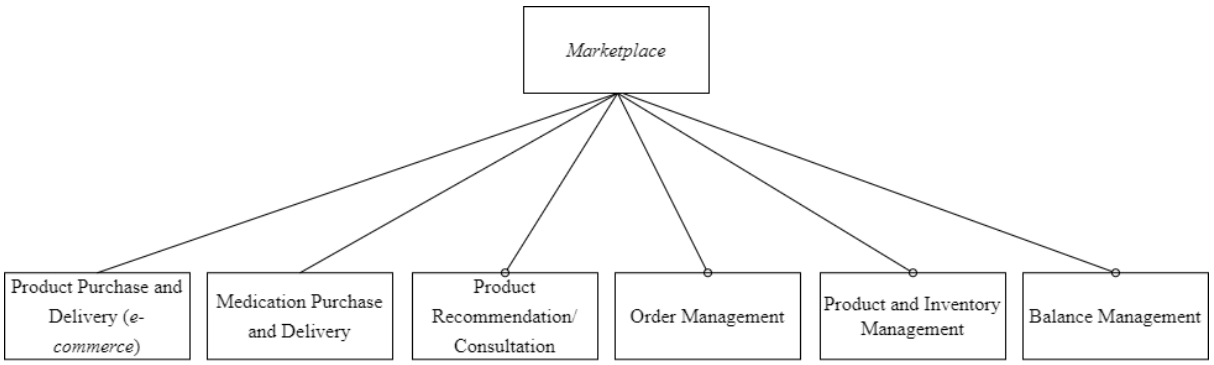


**Figure 10**. Feature Diagram of "Marketplace" Feature

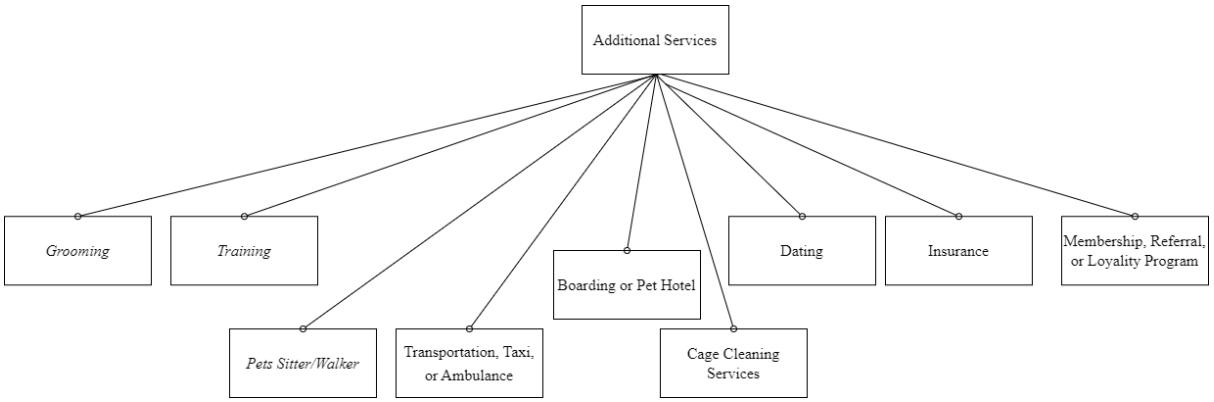


**Figure 11**. Feature Diagram of "Additional Services" Feature

After feature model refinement, an evaluation of the domain analysis process and product was carried out using criteria grouped into three main categories: process, product, and tool support [18]. Domain expert assessment is carried out on a scale of 1 to 5, and then the evaluation result value is obtained using the Equation (5).

$$Evaluation\ Result\ Value = \left(\frac{\sum_{i=1}^{n} (Fi\ x\ Ni)}{X}\right) x100\% \quad (5)$$

where:
- *Fi* is the domain experts provide values for the *i* on criterion scale.
- *Ni* is the value in the *i* on criterion scale.
- *X* is the maximum number of values, or 25.

The results of expert domain validation in this research show that, in general, the feature model from domain analysis meets the users' requirements, with an average evaluation result value of 96%. Aspects that have met users' expectations are relevance, dependability between features, priority, and regulatory compliance. Meanwhile, several aspects that still require improvement are completeness, simplicity, and usability.

## D. Conclusion

The aim of this research is to develop an application feature model for the pet health domain using the FODA method. The analysis of the pet health domain acquired a model with 45 features, consisting of 25 mandatory features and 20 optional features. This feature model has been validated by domain experts, achieving an average validation score of 96%, indicating it meets the users' requirements in the pet health application domain. The feature model for the pet health application domain in this research is limited to the domain requirements engineering stage, so the impact of adding mandatory features to the feature model cannot be implemented to produce product adjustments for the nine applications studied.

The feature modeling in this research is limited to the domain requirements engineering stage, with the aim that it can be reused by organizations or startups in the field of animal health services more broadly. In further research, improvements can be made as follows:

a. CBFM can be implemented for feature modeling development to determine the cardinality of each feature. The research can continue to the domain design stage to develop application prototypes based on feature models and carry out testing with end users to identify problems and areas for improvement, as well as perfect feature models.
b. Implementation of the feature model in the pet health application to test the functionality of the feature model and obtain feedback from users.

## E. References

[1] TGM Research, "TGM Global Pet Care Survey 2023," TGM Research, Singapore,

2023.

[2] CB Insight, "The Top 12 Reasons Startups Fail," CB Information Services, Inc., New York, 2021.

[3] Y. Pratama, "Analisis Model Bisnis Startup Pelayanan Kesehatan Hewan Menggunakan Metode Customer Development," Universitas Indonesia, Depok, 2021.

[4] Humas BSN, "Jaga Kualitas, BSN Tetapkan SNI Pelayanan Kesehatan Hewan," 19 Jan 2024. [Online]. Available: https://bsn.go.id/.

[5] O. Komarudin, D. Adianto and A. Azurat, "Modeling Requirements of Multiple Single Products to Feature Model," *Procedia Computer Science,* p. 107–114, 2019.

[6] K. Pohl, G. Böckle and F. Linden, Software product line engineering: foundations, principles and techniques, Germany: Springer-Verlag Berlin Heidelberg, 2005.

[7] S. Wang, H. S. Lee and W. Choi, "A feature-oriented analysis of developers' descriptions and user reviews of top mHealth applications for diabetes and hypertension," *International Journal of Medical Informatics,* 2021.

[8] A. Safilian, T. Maibaum and Z. Diskin, "A theoretical framework for cardinality-based feature models: The semantics and computational aspects," *Journal of Logical and Algebraic Methods in Programming,* pp. 30-54, 2018.

[9] D. de Castro, A. Cortiñas, M. R. Luaces, O. Pedreira and Á. S. Places, "Local features: Enhancing variability modeling in software product lines," *The Journal of Systems & Software,* 2024.

[10] M. Raatikainen, J. Tiihonen and T. Männistöb, "Software product lines and variability modeling: A tertiary study," *The Journal of Systems and Software,* p. 485–510, 2019.

[11] K. C. Kang, S. G. Cohen, J. A. Hess, W. E. Novak and A. S. Peterson, "Feature-Oriented Domain Analysis (FODA) Feasibility Study," Software Engineering Institute, Carnegie Mellon University, Pittsburgh, 1990.

[12] K. Czarnecki and U. W. Eisenecker, Generative Programming: Methods, Tools, and Applications, Addison-Wesley, 2000.

[13] K. Czarnecki and C. H. P. Kim, "Cardinality-Based Feature Modeling and Constraints: A Progress Report," in *Workshop on Software Factories*, San Diego, California, 2005.

[14] C. Andrés, C. Camacho and L. Llana, "A formal framework for software product lines," *Information and Software Technology,* 2013.

[15] M. Sauders, P. Lewis and A. Thornhill, Research Methods for Business Students, Sixth Edition, Essex, England: Pearson Education Limited, 2012.

[16] J. W. Creswell and J. D. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Fifth Edition, California: SAGE Publications Inc., 2014.

[17] Czarnecki, "Domain Engineering," in *Generative Programming: Principles and Techniques of Software Engineering Based on Automated Configuration and Fragment-Based Component Models.*, Germany, Technische Universität Ilmenau, 1998, pp. 33-65.

[18] Y. Lee and W. Zhao, "Domain Requirements Elicitation and Analysis-An Ontology-Based Approach," in *The International Conference on Computational Science 2006*, Reading, UK, 2006.

[19] U. K. d. M. Pramono, Materi Pelatihan Berbasis Kompetensi Berbasis SKKNI Level IV Kesehatan Hewan, Kementerian Pendidikan dan Kebudayaan, 2019.

[20] T. L. Saaty, "Decision making with the analytic hierarchy process," *International Journal of Services Sciences,* pp. 83-98, 2008.

[21] E. Mu and M. P. Rojas, "Understanding the Analytic Hierarchy Process," in *Practical Decision Making*, SpringerBriefs in Operations Research, 2017.

[22] J. Lee and D. Muthig, "Feature-Oriented Variability Management in Product Line Engineering," *Communications of the ACM,* pp. 55-59, 2006.

[23] R. Ukor, G. Armitt and H. Dexter, "A cross-disciplinary approach to early requirements validation in supporting medical education," *Joint Information Services Committee (JISC),* 2008.

[24] J.-M. Horcas, J. A. Galindo, R. Heradio and D. F. Amoros, "A Monte Carlo tree search conceptual framework for feature model analyses," *The Journal of Systems & Software,* 2023.

[25] Wahyudianto, E. K. Budiardjo and E. M. Zamzami, "Feature Modeling and Variability Modeling Syntactic Notation Comparison and Mapping," *Journal of Computer and Communications,* pp. 101-108, 2014.

[26] A. Gómez and I. Ramos, "Cardinality-Based Feature Modeling and Model-Driven Engineering: Fitting them Together," 2010.