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Expert system for early detection of autism in children using forward chaining method based on android

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Abstract

Purpose: This study aims to design and develop an Android-based expert system for early detection of Autism Spectrum Disorder in children using the Forward Chaining inference method. The system supports parents and educators in recognizing symptoms and bridging the gap between early identification and professional intervention.

Methodology/approach: This research adopts a research and development approach using a prototype model. Data were collected through literature review, observation, and expert interviews with child development specialists. The expert system applies Forward Chaining using a rule-based knowledge base covering three ASD severity levels and 27 validated symptoms. System performance was evaluated.

Results/findings: The study developed an Android-based expert system to identify autism symptoms and classify severity levels. The system achieved 92% accuracy compared with expert diagnoses, while functional testing confirmed all features operated correctly, including symptom input, diagnostic results, and online clinic reservation.

Conclusions: The Android-based expert system using the Forward Chaining method is effective and reliable for supporting early autism detection. Its logical and transparent inference process makes it suitable for non-expert users, while the integration with healthcare services strengthens early intervention efforts.

Limitations: The system relies on predefined rules and symptom data, which may not capture the full variability of autism manifestations. The application also does not replace professional clinical diagnosis and is limited to early screening purposes.

Contribution: This study contributes a lightweight and accessible mobile expert system for autism detection, integrating diagnostic support with professional access, delivering practical value for parents, educators, and early childhood intervention programs.

Keywords: *Android Application, Autism, Early Detection, Expert System, Forward Chaining*

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1. Introduction

The growth and development of children are complex and varied processes. One condition that requires special attention is Autism Spectrum Disorder (ASD). Autism is a neurodevelopmental disorder

characterized by difficulties in social interaction, communication, and the presence of restricted and repetitive behavior patterns or interests (Purboningrum & Utaminingrum, 2024). Data from the World Health Organization (WHO) in 2018 showed that the prevalence of autism was estimated to be 1 in 160 children globally, and a systematic review in 2022 reported that this number had increased to 1 in 100 children worldwide (Krishnappa Babu et al., 2024). This increase in prevalence indicates the importance of early detection and intervention, as early intervention can provide significant benefits to a child's development (Zeidan et al., 2022).

However, many parents and educators still lack an understanding of the early signs of autism, which are often difficult to recognize because they vary from child to child (Lord et al., 2020). This lack of understanding hampers diagnosis and necessary treatment, impacting the overall development of the child (D. B. Pratama & Armin, 2025). To address this challenge, technology can be used to simplify the process of identifying symptoms. Expert systems, a branch of artificial intelligence, are designed to mimic the reasoning of an expert in solving problems in a specific field (Ghosh et al., 2021).

Previous research has demonstrated that the Forward Chaining method is effective for expert systems in determining children's autism levels by systematically inferring diagnostic conclusions from observed symptoms (Asrianto, Kartini, & Amalia, 2023). Munir et al. (2021) implemented a rule-based expert system integrated with an educational game to classify autism severity, showing that Forward Chaining provides a transparent and logical reasoning process that can be easily understood by non-expert users, such as parents and educators. Their findings indicate that combining expert systems with interactive digital media enhances user engagement while maintaining diagnostic clarity (Putra, Rahmadi, & Armin, 2025).

This approach supports the suitability of Forward Chaining for early autism screening applications, particularly in mobile-based environments, where accessibility, simplicity, and user comprehension are critical for effective early detection (Zayniddinovna, 2025). This study proposes the development of an Android-based mobile application that implements an expert system for the early detection of autism symptoms (Nabilla & Wibisono, 2025). The application uses the Forward Chaining inference method, which is suitable for processing factual data into conclusions. This approach allows the system to check the validity of the symptoms inputted by the user and match them with existing rules to draw relevant conclusions.

Unlike previous studies, such as that of Fuad, Aminullah, Soni, and Rizki (2022), who developed a web-based expert system for autism, this research specifically focuses on an Android-based mobile application. Additionally, this study not only provides an initial diagnosis but also connects users with professional child development clinics, a feature that has not been widely integrated into similar research (T. W. Pratama, Astuti, & Buntoro, 2019). This is expected to bridge the gap between early detection and reliable follow-up. Thus, the research problem in this study is how to apply the Forward Chaining method in a mobile application to enhance the effectiveness of identifying autism symptoms and how this application can facilitate communication between parents/guardians and trusted clinics for further management.

2. Literature Review and Hypothesis Development

2.1. Expert System

An expert system is defined as a computer program that mimics the knowledge and expertise of a human expert in a specific field to solve problems or draw conclusions (Evansyah, 2025). This system consists of a knowledge base containing expert experience and an inference engine that performs reasoning to generate conclusions (Ariska & Yulianton, 2023).

2.2. Forward Chaining

Forward Chaining is a method that works from known facts to conclusions (Gusman & Hendri, 2019). The process begins by collecting data or symptoms input by users. The inference engine then processes these facts and matches them with rules stored in the knowledge base (Oktavia, Ramadini, & Wahyuni, 2025). If the premises of a rule match the existing facts, the rule is executed and a new conclusion (new

fact) is generated. This process continues until no more rules can be executed and a final conclusion is obtained (Pasalli, Poekoel, & Najoan, 2016).

2.3. Autisme

Autism or Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that affects communication, social interaction, and repetitive behaviors in children (Ginting, Zarlis, & Rosnelly, 2021). Autism symptoms are divided into two main categories: communication and social interaction disorders and behavioral pattern disorders (Irawan, Raharjo, Mulyono, & Afifi, 2022). According to the DSM-5, the severity levels of autism are divided into three levels: Level 1 ("Requiring Support"), Level 2 ("Requiring Substantial Support"), and Level 3 ("Requiring Very Substantial Support") (Garcia et al., 2024).

2.4. Mobile Application

According to Buyens (2001), the term mobile application is a combination of the words application and mobile. Application refers to implementation or use, which, in the technological context, denotes ready-to-use software designed to perform specific functions for users or other applications (Lesmana, 2017). Mobile means are capable of moving from one place to another. Purnama (2010) explained that a mobile application is a software that runs on mobile devices. The presence of mobile applications makes it easier for users to perform various activities, ranging from entertainment, trading, learning, and completing office tasks to browsing the Internet (Ramadhan et al., 2025).

2.5. Development of Hypotheses from Previous Research

This study refers to several relevant previous studies to strengthen the foundation of the arguments. Based on a review of prior research, several hypotheses can be formulated as follows:

1. Irawan et al. (2022) developed an application to help parents recognize the early symptoms of autism (SDA-03 Application).
   Extended Hypothesis: By adopting a similar approach but using a more structured method, such as Forward Chaining, the application can provide more accurate and detailed diagnostic results, not only introducing symptoms but also determining the severity level of autism.
2. Purboningrum and Utaminingrum (2024) used face recognition and deep learning for early ASD detection with high accuracy (Purboningrum & Utaminingrum, 2024).
   Extended Hypothesis: Although deep learning methods offer high accuracy, this study hypothesizes that an expert system based on Forward Chaining provides a solution that is easier to implement, lighter for mobile devices, and more transparent in its decision-making process, making it easier for lay users, such as parents, to understand.
3. Fuad et al. (2022) also applied the Forward Chaining method for web-based autism diagnosis.
   Extended Hypothesis: Although same method is effective, implementation on the Android platform is expected to increase accessibility and ease of use. Therefore, the proposed hypothesis is that an Android-based application using Forward Chaining will be more practical and able to reach more users than the web version, potentially improving the overall effectiveness of early detection programs.
4. Utami and Laksono (2024) used fuzzy logic to assist in diagnosing autism symptoms and their severity in a web-based system.
   Extended Hypothesis: Compared with the complexity of fuzzy logic, this study hypothesizes that the Forward Chaining approach can provide sufficiently accurate results with simpler logic, making system development and maintenance more efficient.

3. Research Methodology

This research methodology adopts a research and development approach using a prototype model. The process begins with a requirements analysis, followed by system design, implementation, and testing.

3.1. Data Collection Techniques

Data were collected using three main methods.

1. Literature Study: Gathering information from previous research, books, articles, and journals related to autism, expert systems, and application development.

2. Observation: Observing and describing the object of study to collect relevant data to be analyzed.
3. Interviews: Direct interviews were conducted with the owner and doctors at Pelangi Hati Child Development Clinic, Bandar Lampung City, to obtain accurate information regarding symptoms and diagnostic procedures.

3.2. System Testing

System testing was performed using two methods.

1. Black Box Testing: Testing the application's functionality in terms of input and output without examining the internal code. This testing ensures that each feature, such as login, form completion, and the diagnostic process, functions as intended.
2. White Box Testing: Analyzing the internal structure and program code, especially at the module level, to detect errors and weaknesses. This method was measured using Cyclomatic Complexity to calculate the number of independent paths in the program.

3.3. Inference Method: Forward Chaining

The primary method used is Forward Chaining. This method works from known facts to conclusions. The process begins by collecting data or symptoms input by users. The inference engine then processes these facts and matches them with the rules stored in the knowledge base (Ariska & Yulianton, 2023). If the premises of a rule match the existing facts, the rule is executed and a new conclusion (new fact) is generated. This process continues until no more rules can be executed, and the final conclusion is obtained. In the context of this application, the knowledge base consists of three autism levels (L1, L2, and L3) and 27 symptoms (G1–G27) used as diagnostic criteria. These rules are presented in an IF–THEN format, where combinations of symptoms (IF) lead to the diagnosis of a specific level of autism (THEN).

3.4. Application Design

The application was designed using a prototype method. The design stages included:

1. Requirements Analysis: Identifying required features, such as the diagnosis page, online reservation, and user reviews.
2. User Interface Design: Initial interactive and user-friendly designs were created, including layouts for the login page, admin dashboard, diagnosis page, and reservation page.
3. Database Design: An entity relationship diagram (ERD) was used to model the relationships between entities (admins, tb_autism, tb_ symtpoms, etc.) and a Logical Record Structure (LRS) was used to convert them into relational tables.
4. System Diagram Design: Use case diagrams to illustrate interactions between actors (users and admins) and the system, as well as activity and sequence diagrams to model workflows and object interactions in detail (Giofran, Fanani, & Ananta, 2024).

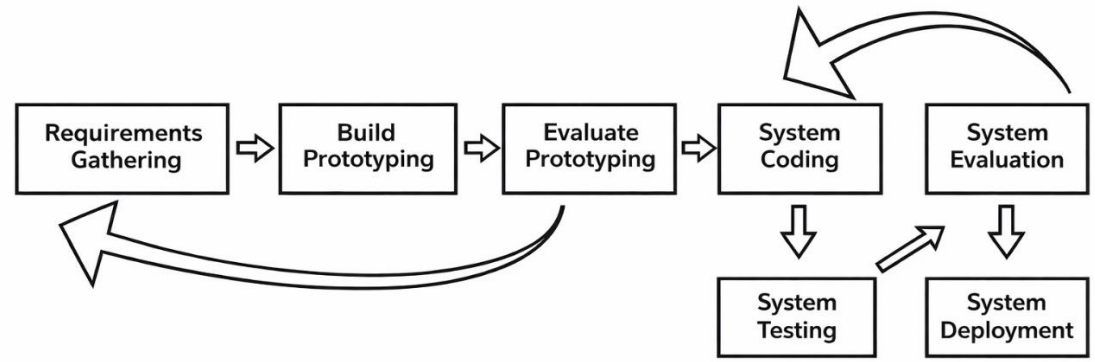

Figure 1. Prototype Method

3.5. Flowchart Analysis of the Proposed System

The proposed system aims to assist users, particularly parents and healthcare professionals, in the early detection of autism symptoms in children aged 3 months to 3 years. This Android-based application utilizes the Forward Chaining method, where symptoms selected by the user are matched with the rules

available in the system to generate an initial diagnosis, along with relevant recommendations and preventive measures.

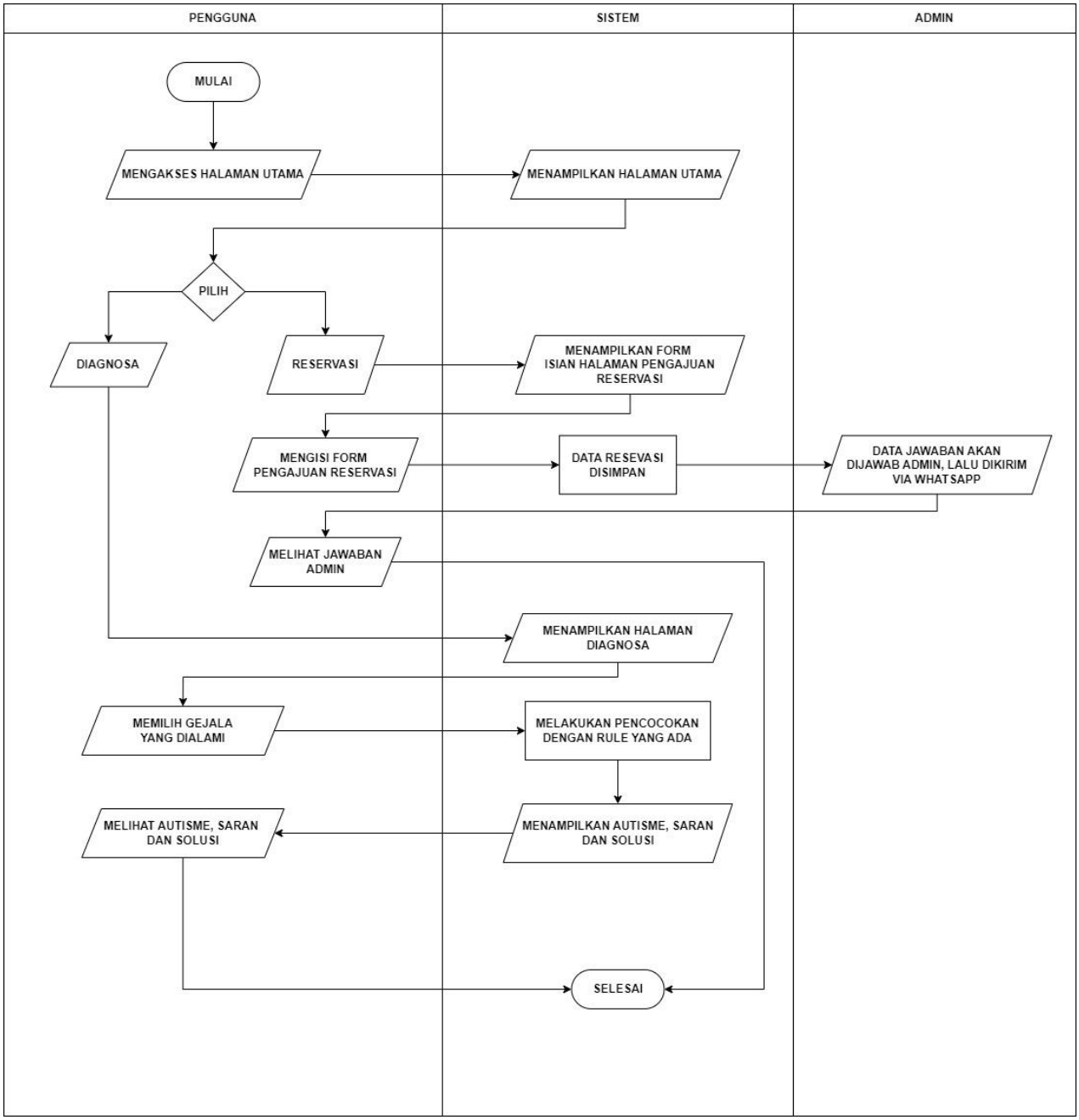

Figure 2. System Analysis

3.6. Use Case Diagram Design

A Use Case is a description of the expected functionality of a system that illustrates the interactions between actors and the system. The use case that will be developed in this study is as follows:

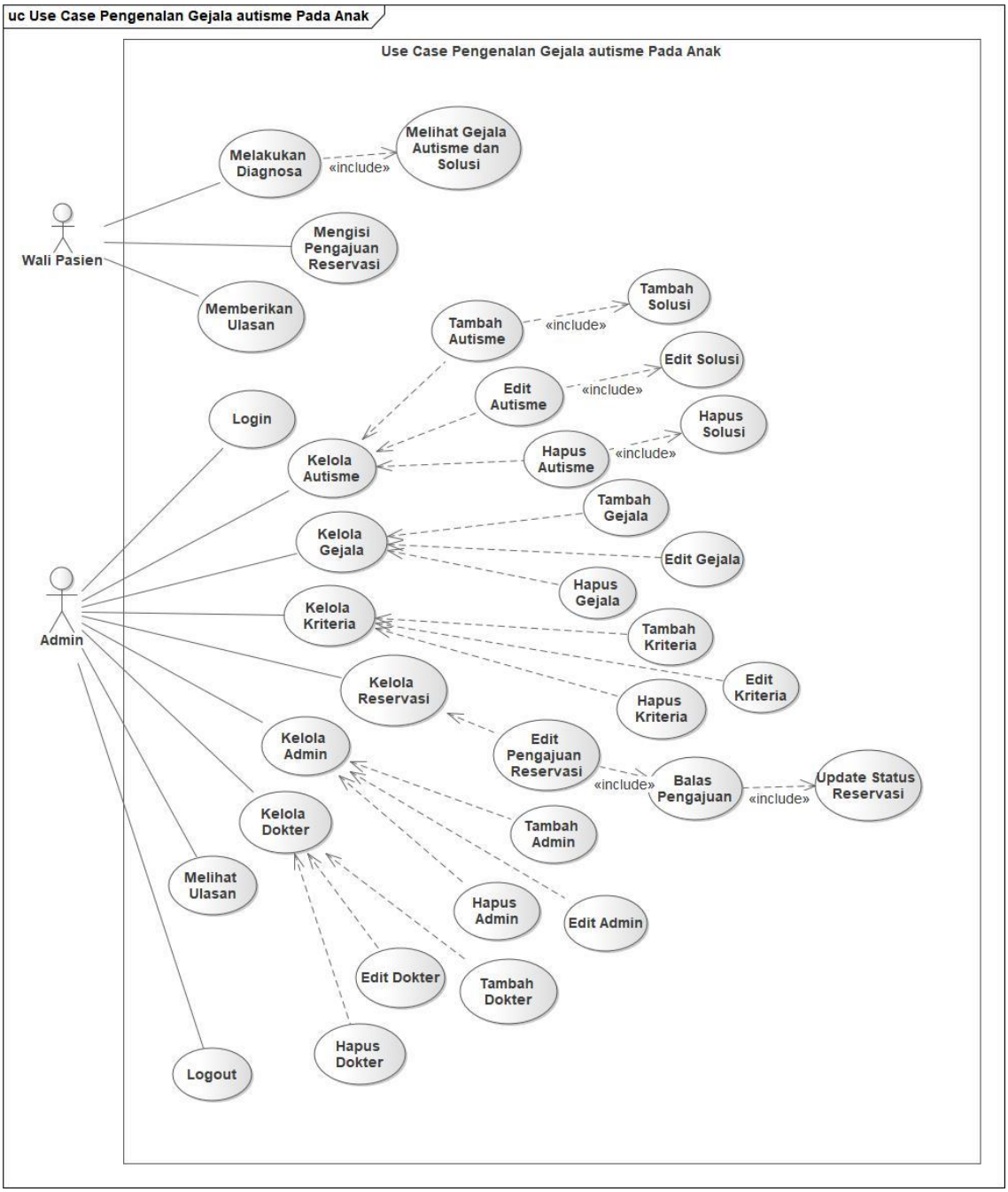

Figure 3. Use Case Diagram

3.7. Activity Diagram for Diagnosis Process

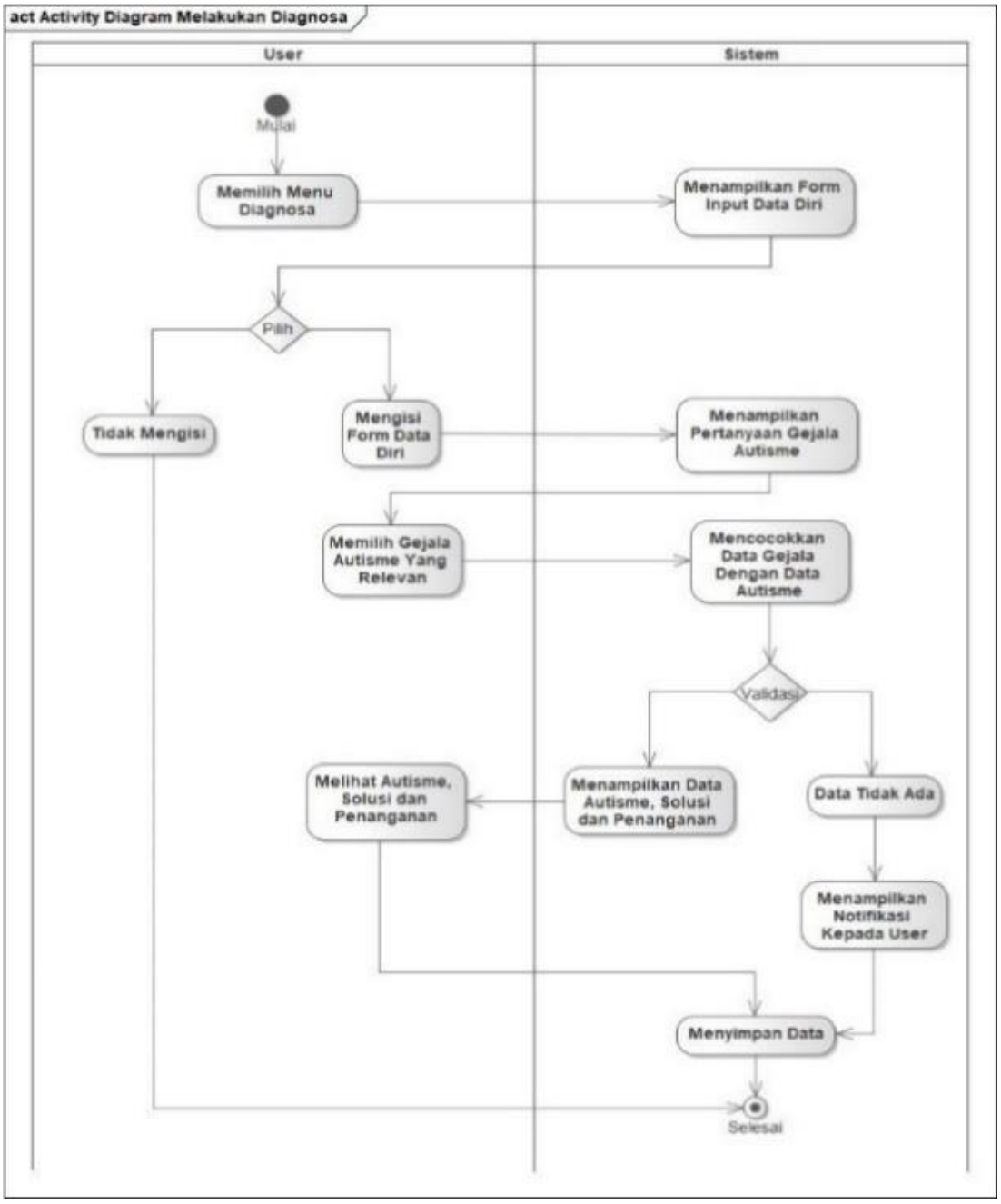

Figure 4. Activity Diagram for Diagnosis Process

3.8. Activity Diagram for Reservation Submission

The design of the activity diagram for the reservation submission process in the system is as follows.

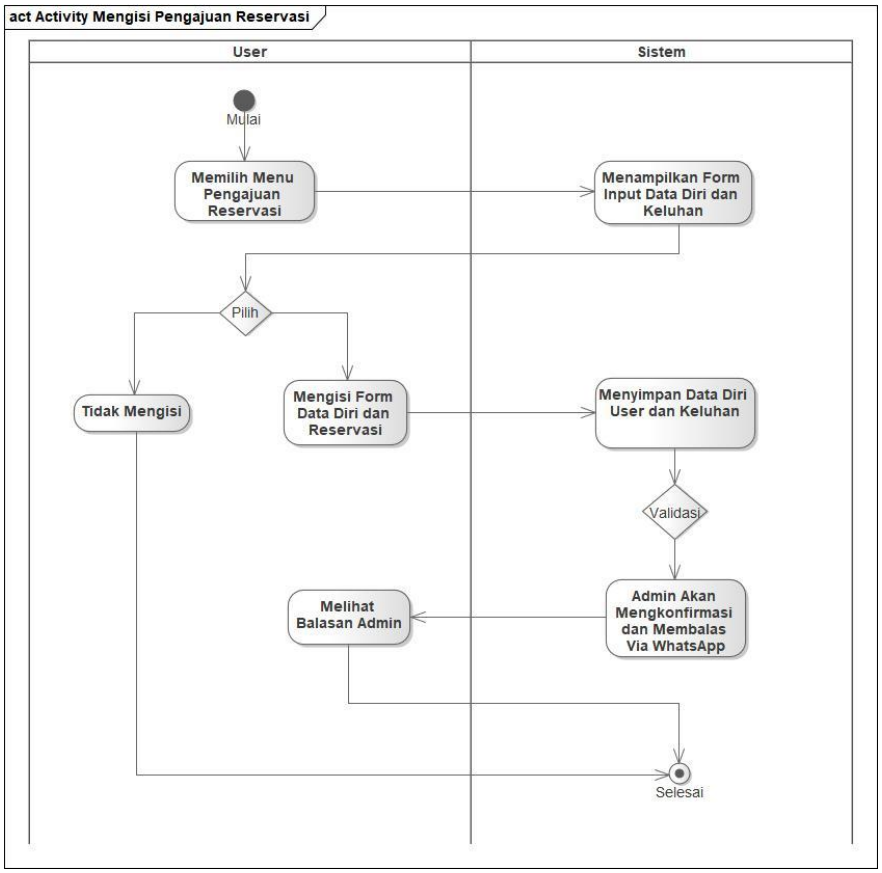

Figure 5. Activity Diagram for Reservation Submission

3.9. Class Diagram Design

This class diagram was designed for the Autism Symptoms Recognition System in children, which includes several key entities. The admin entity is used to manage admin data, including the username, password, and other information.

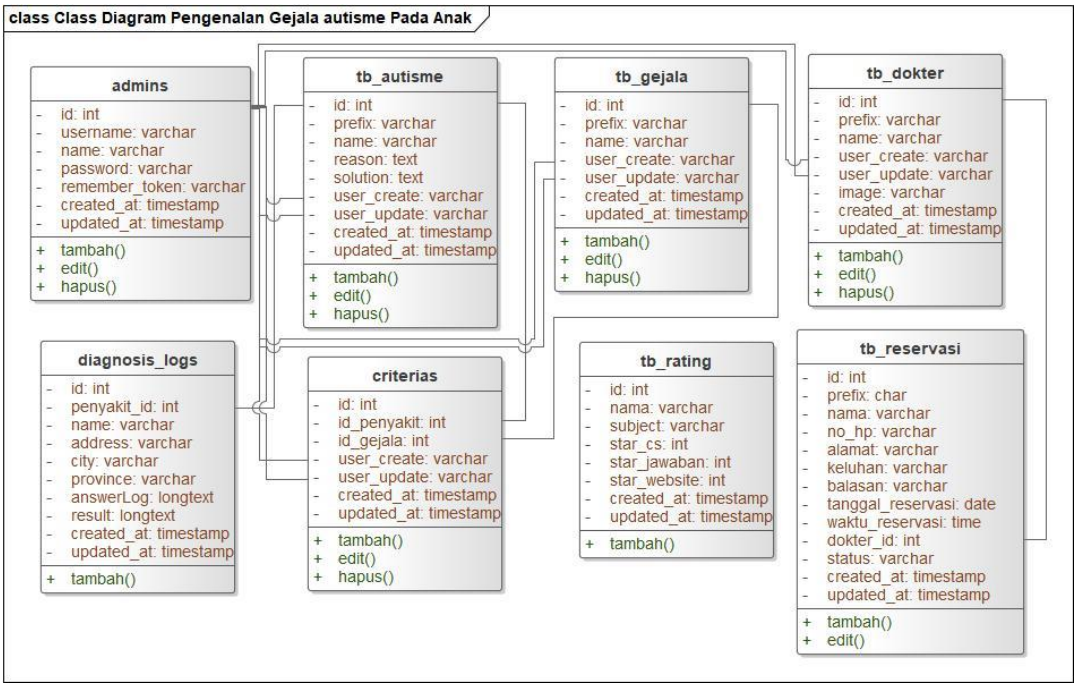

Figure 6. Class Diagram Design

3.10. Admin Dashboard User Interface Design

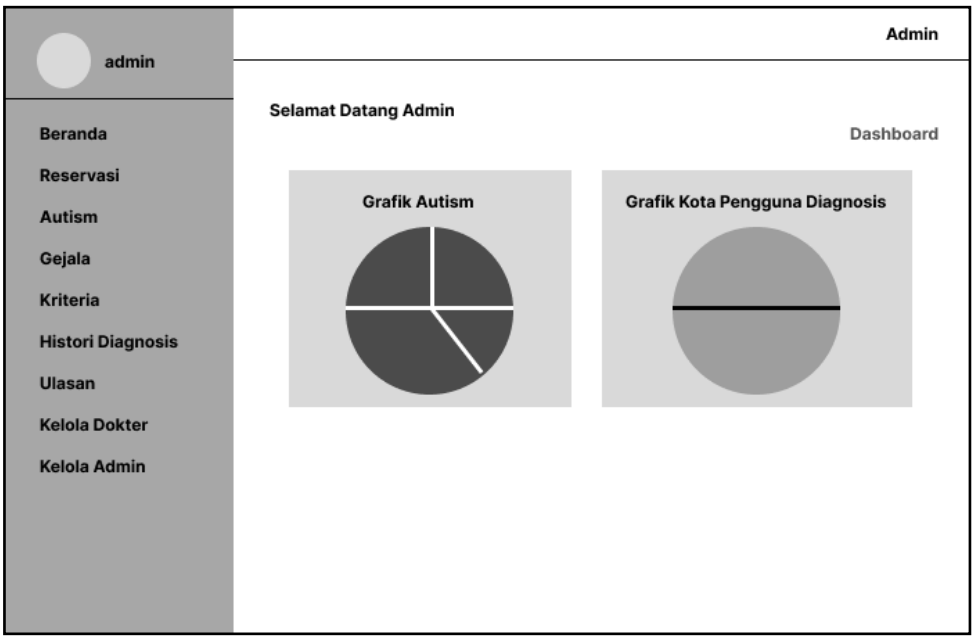

Figure 7. Admin Dashboard User Interface Design

3.11. Admin Rule Criteria Page User Interface Design

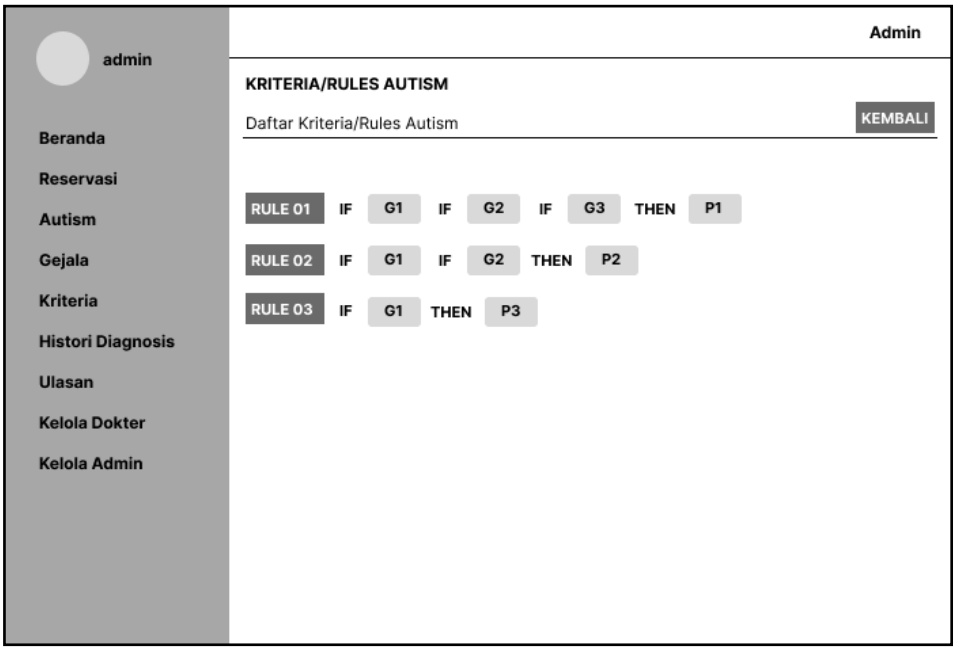

Figure 8. Rule Criteria Page Design

3.12. Main Page User Interface Desig

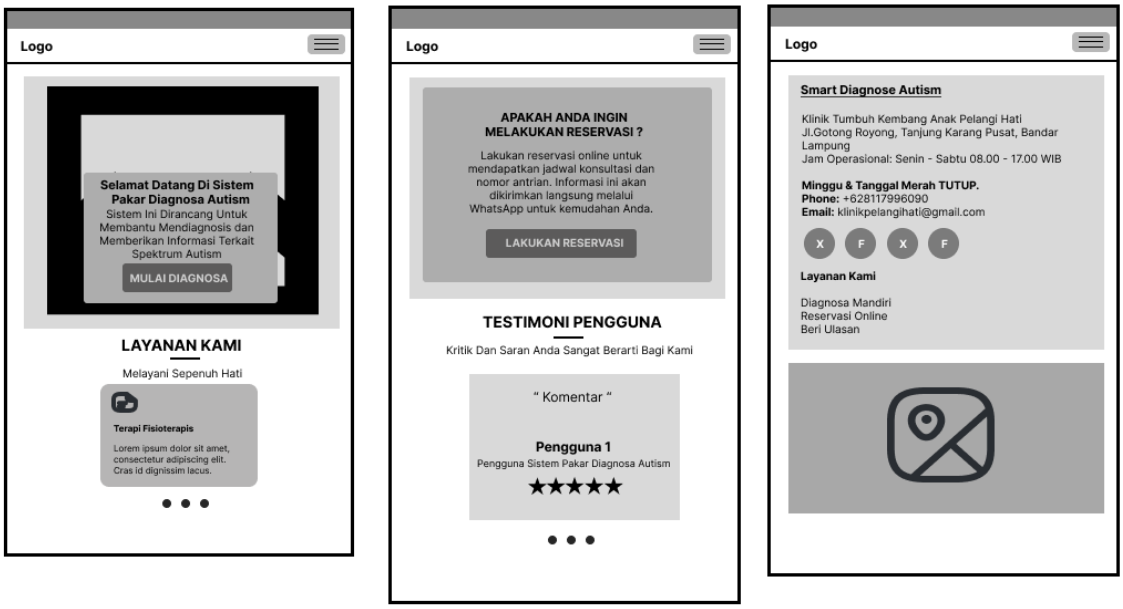

Figure 9. Main Page Design

3.13. Autism Data and Autism Codes

Table 1. Autism Data and Codes

Code	Name of Autism Spectrum Disorder (ASD
L1	Level 1 "Requiring Support" / Needs Support
L2	Level 2 "Requiring Substantial Support" / Needs Substantial Support
L3	Level 3 "Requiring Very Substantial Support" / Needs Very Substantial Support

3.14. Symptom Data and Symptom Codes

Table 2. Symptom Data and Symptom Codes

Code	Symptom	L1	L2	L3
G1	Does the child struggle to use body language, eye contact, or gestures for communication, but is willing to try when directed?	✓		
G2	Does the child seem to have difficulty starting or maintaining a conversation with others without prompts?	✓		
G3	Does the child show odd or inappropriate responses to social cues, such as facial expressions, unusual tone of voice, or disinterest in peers?	✓		
G4	Does the child frequently have difficulty transitioning from one activity to another?	✓		
G5	Does the child have a very narrow interest in specific things, like numbers, vehicles, or certain animals?	✓		
G6	Does the child show repetitive movements, like hand flapping, that can be stopped if directed?	✓		
G7	Does the child have difficulty adjusting behavior in social situations, such as when playing with peers, but can do so with minimal help (e.g., being prompted to say hello or respond)?	✓	✓	
G8	Does the child have specific routines that are difficult to change, but can still be directed to try something new (e.g., must take a specific route to school)?	✓		

G9	Does the child have specific routines that are difficult to change, but can still be directed to try something new (e.g., must take a specific route to school)?		✓	✓
G10	Does the child's social interaction tend to be limited to very narrow topics or interests (e.g., only talking or playing with trains or other specific things)?			
G11	Does the child show odd non-verbal communication responses, like avoiding eye contact or showing inappropriate facial expressions?		✓	
G12	Does the child only respond to specific social cues with minimal initiative to start interactions?		✓	
G13	Does the child have considerable difficulty coping with changes in routine?		✓	
G14	Does the child engage in repetitive behaviors, like organizing objects or repeating words, that are difficult to stop?		✓	
G15	Does the child show highly specific and obsessive interests in certain things?		✓	
G16	Does the child seem unable to focus on new tasks due to being too focused on certain activities or objects?		✓	
G17	Does the child have rigid habits or routines that are hard to interrupt?		✓	
G18	Does the child overreact to loud sounds, bright lights, or certain textures, making it hard to engage in activities?		✓	✓
G19	Does the child rarely initiate social interaction, even when given the opportunity?			✓
G20	Does the child use very limited or difficult-to-understand verbal communication?			✓
G21	Does the child only respond to very direct social cues, typically to meet their own needs?			✓
G22	Apakah Does the child seem almost completely avoidant of social interactions with others, even in familiar environments?			✓
G23	Does the child show extreme emotional reactions when routines are disrupted, even with minor changes?			✓
G24	Does the child continue repetitive behaviors, like body rocking, for long periods without being able to stop?			✓
G25	Does the child show extreme interest in specific objects, such as playing only with the same toy or focusing on a single activity?			✓
G26	Does the child fail to adjust behavior in social situations, even with intensive help?			✓
G27	Have these symptoms been present since early childhood and affect almost all aspects of the child's life?	✓	✓	✓

3.15. Rule Representation

Table 3. Rule Data and Symptom Codes

Code	Rule
R1	If the child struggles to use body language, eye contact, or gestures for communication but is willing to try when directed is True And the child has difficulty starting or maintaining a conversation with others without prompts is True And the child shows odd responses to social cues, like facial expressions, unusual tone of voice, or disinterest in peers is True And the child often struggles to transition from one activity to another is True And the child has a very narrow interest in specific things is True And the child shows repetitive movements, like hand flapping, that can be stopped if directed is True

	And the child has difficulty adjusting behavior in social situations but can do so with some help is True And the child has a specific routine that is hard to change but can be directed to try something new is True And these symptoms have been present since early childhood and affect almost all aspects of the child's life Then Level 1 "Requiring Support"
R2	If the child has difficulty adjusting behavior in social situations but can do so with some help is True And the child often struggles to use body language, eye contact, or gestures for communication, even with help is True And the child's social interaction is limited to very narrow topics or interests is True And the child shows odd non-verbal responses like avoiding eye contact is True And the child responds to social cues with minimal initiative is True And the child has significant difficulty coping with changes in routine is True And the child engages in repetitive behaviors that are hard to stop is True And the child has very specific and obsessive interests is True And the child has difficulty focusing on new tasks due to excessive focus on specific objects or activities is True And the child has rigid habits that are difficult to stop is True And the child overreacts to loud sounds, bright lights, or certain textures is True And these symptoms have been present since early childhood and affect almost all aspects of the child's life Then Level 2 "Requiring Substantial Support
R3	If the child often struggles to use body language, eye contact, or gestures for communication, even with help is True And the child overreacts to loud sounds, bright lights, or certain textures is True And the child rarely initiates social interactions is True And the child uses very limited or difficult-to-understand verbal communication is True And the child only responds to direct social cues for their own needs is True And the child almost completely avoids social interactions is True And the child has extreme emotional reactions to routine changes is True And the child continues repetitive behaviors for long periods is True And the child shows extreme interest in specific objects is True And the child fails to adjust behavior in social situations, even with intensive help is True And these symptoms have been present since early childhood and affect almost all aspects of the child's life Then Level 3 "Requiring Very Substantial Support"

3.16. Decision Tree

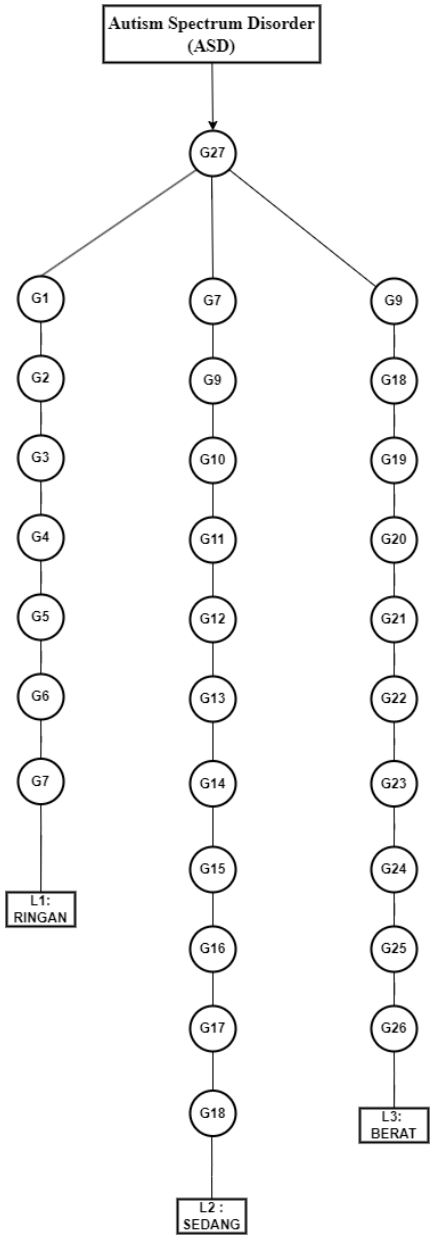

Figure 10. Decision Tree

4. Results and Discussion

The result of this research is an Android-based expert system application for the early detection of autism symptoms. This application was developed using the PHP programming language and MySQL database.

4.1. Application Implementation

This application has two main user roles: Admin and User. The Admin can manage all data in the system, including autism data, symptoms, diagnostic criteria, doctors, reservations, and reviews. The admin interface is designed with a dashboard that displays graphs of autism prevalence and user locations, assisting in strategic decision-making. Users can access the application to perform diagnoses and make reservations online. The diagnosis process begins with filling out personal data, followed by selecting symptoms experienced by the child with options "Yes" or "No." After completing this process, the system displays the diagnosis result in the form of an autism level (Level 1, 2, or 3), matching percentage, and relevant recommendations and solutions for handling.

4.1.1. Admin Dashboard Page

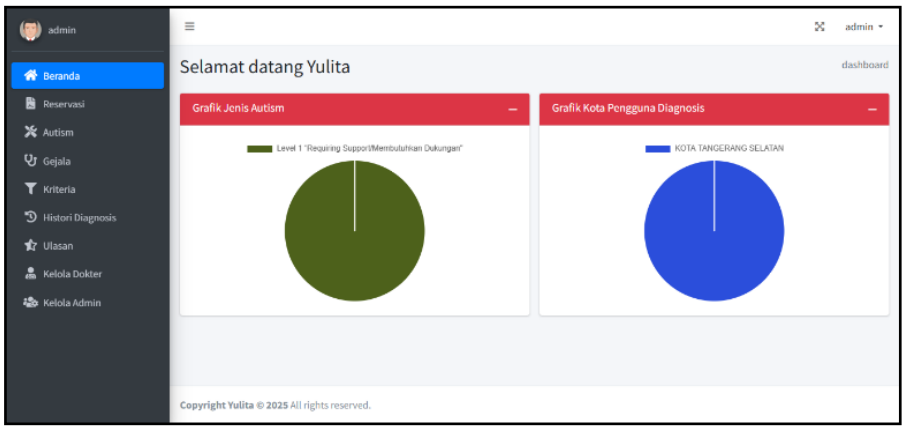

Figure 11. Admin Dashboard Page

4.1.2. Autism Page

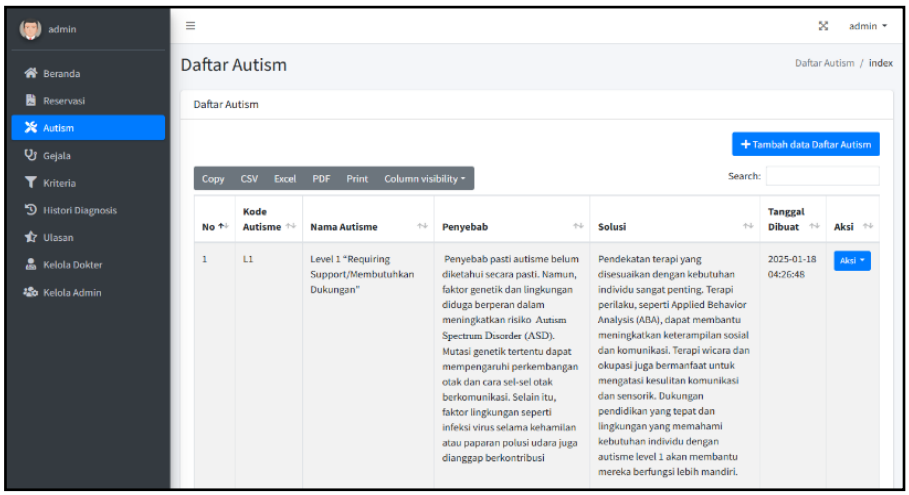

Figure 12. Autism Page

4.1.3. Rule Criteria Page

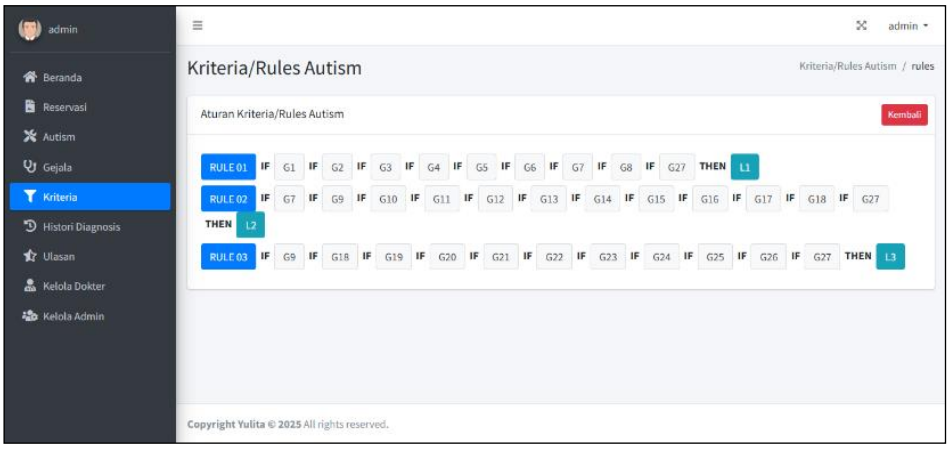

Figure 13. Rule Criteria Page

4.1.4. User Main Page

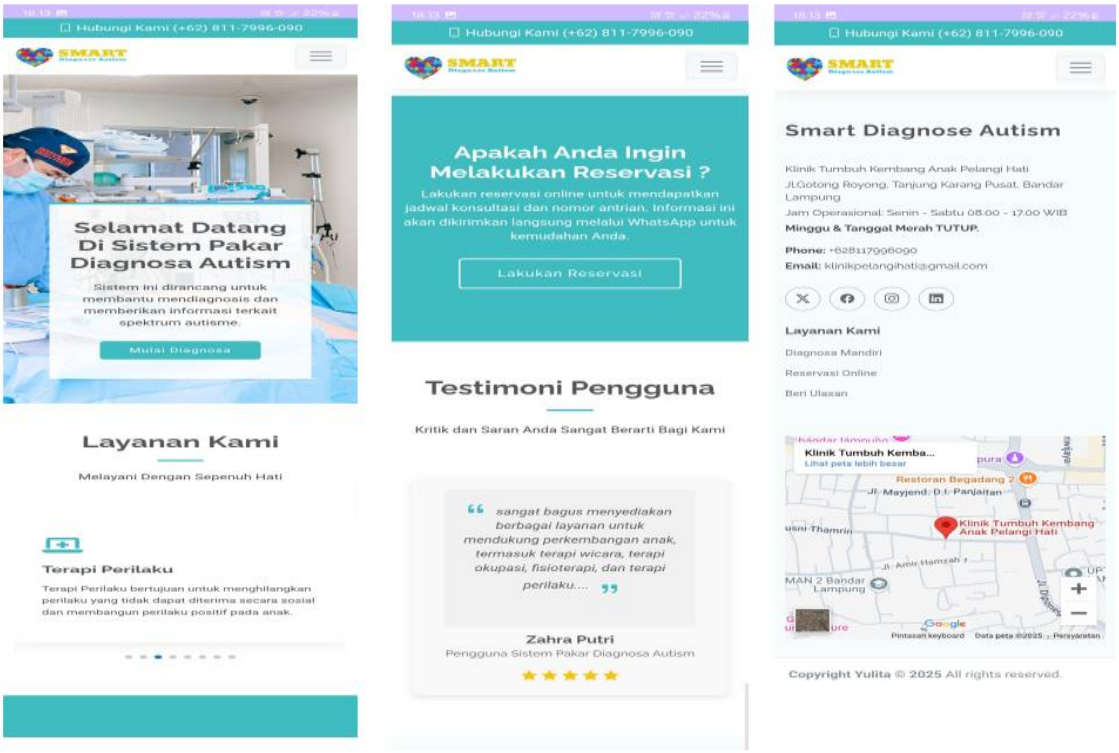

Figure 14. User Main Page

4.1.5. Personal Data Diagnosis Form Page

Figure 15. Personal Data Form

4.1.6. Diagnosis Process Page

Figure 16. Diagnosis Process Page

4.1.7. Diagnosis Result Page

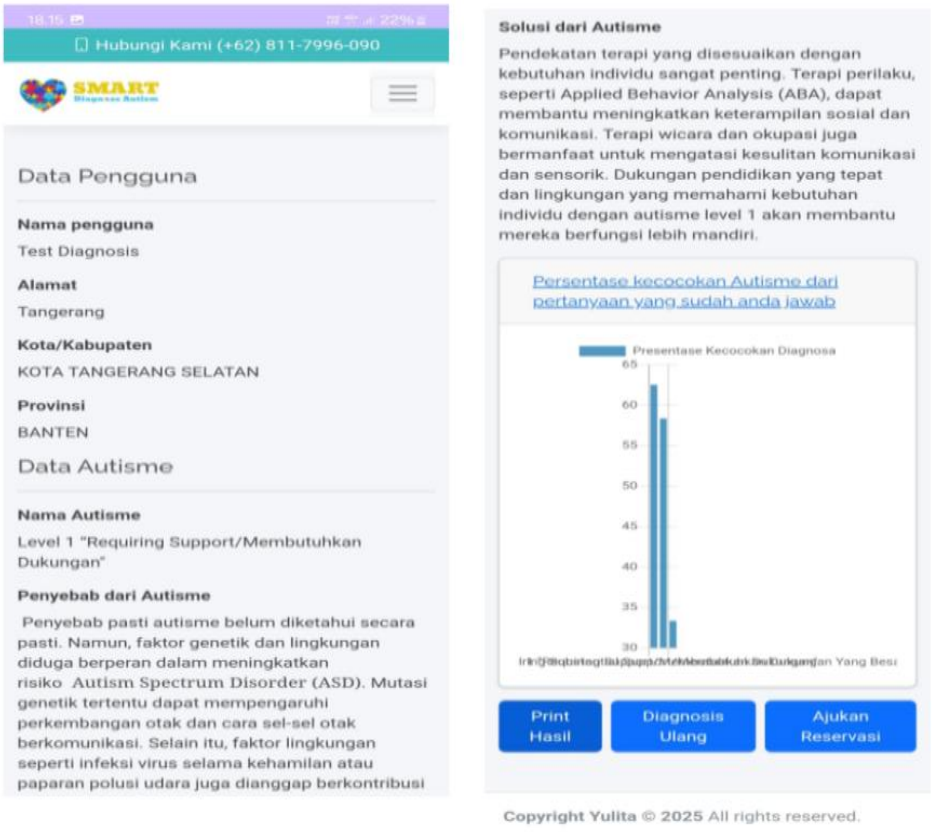

Figure 17. Diagnosis Result Page

4.1.8. Reservation Submission Page

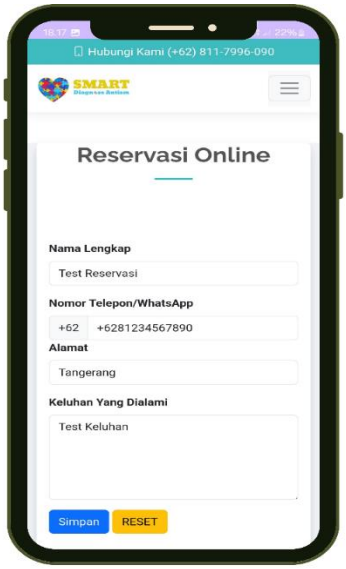

Figure 18. Reservation Submission Page

4.2. System Accuracy and Functionality

System feasibility testing was conducted using black-box and white-box testing methods. The results of black box testing showed that all application functions worked as expected. For example, login validation, form filling, and data storage processes were completed successfully, without errors. This test confirmed that the application was responsive and met the functional requirements. The system's accuracy in identifying autism symptoms reached 92% based on testing with real cases at the Pelangi Hati Child Development Clinic. This result was obtained by comparing the system diagnosis with the diagnosis provided by the expert. This high accuracy is supported by the application of the systematic Forward Chaining method, where each symptom selected by the user logically leads to the most appropriate diagnosis conclusion based on the knowledge base validated by experts.

4.3. Comparison with Previous Studies

This study has several advantages over previous studies. While Fuad et al. (2022) and Utami and Laksono (2024) designed similar systems based on web platforms, this study focuses on the Android platform, which offers greater mobility and accessibility for parents who are often on the go. This approach allows early detection to be carried out anytime and anywhere, which is very important given the busy nature of modern life. In addition, the online reservation feature and connection to trusted clinics are added values that differentiate this system. It not only provides information but also facilitates actual intervention steps, which is a major barrier identified in the background of the problem.

5. Conclusions

5.1. Conclusion

This study successfully developed an Android-based expert system application for the early detection of autism in children using the Forward Chaining method. The application has proven effective in analyzing symptoms input by users and producing diagnostic conclusions with an accuracy of 92%. The application of the Forward Chaining method ensures a logical and systematic reasoning process, making it a reliable tool for parents and educators. Furthermore, the feature that connects users to professional clinics facilitates access to early intervention, addressing one of the main challenges in the management of autism. Overall, this application provides a practical and informative solution for supporting the early detection and management of autism in children.

5.2. Suggestions

For future development, several recommendations are proposed to improve the quality of the application.

1. Enriching the Knowledge Base: Adding more detailed and comprehensive references on autism symptoms to cover a wider spectrum, thus making diagnosis more accurate.
2. Integrating Additional Methods: Combining Forward Chaining with other artificial intelligence methods, such as Machine Learning, to enhance the accuracy and personalization of diagnoses over time.
3. Digital Medical Record Integration: Connecting the system with a digital medical record platform to facilitate the coordinated tracking of a child's development between parents and healthcare professionals.

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