

EXPERT SYSTEM FOR CLASSIFYING AUTISM CHILDREN'S INDEPENDENCE LEVEL FROM DAILY ACTIVITY USING FORWARD CHAINING

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Abstract— Children with Autism Spectrum Disorder (ASD) require early intervention during their developmental stages. Currently, the availability of experts capable of accurately classifying the independence levels of children with ASD remains limited. Determining these independence levels is crucial, as it serves as the basis for establishing appropriate early interventions. The system aims to assist specialists in conducting more consistent and efficient assessments. This study contributes a novel application of a forward chaining-based expert system for classifying ASD children's independence levels, integrating rule-based reasoning with user-centered evaluation, which distinguishes it from previous studies that primarily focus on diagnosis rather than functional independence assessment. Data were collected from three institutions: two Public Special Need Schools and a Regional Technical Implementation Unit of Children with Special Needs in East Java. The dataset consists of 400 records encompassing five daily activities: eating, drinking, brushing teeth, dressing, and taking off clothes. The independence levels are classified into three categories: independent, partially independent, and dependent. This research consists of seven stages, namely data collection, rule based system using forward chaining, database design using CDM and PDM, user interface development, implementation of the Next.js framework system and PostgreSQL database, system testing, and system evaluation. The results of the study showed that the accuracy was 98.5% and the user satisfaction score was 80.85%. These results indicate that the proposed method is effective in supporting therapists in determining the level of independence of children with ASD based on rules established by experts.

Keywords: Autism, Child Health, Classification, Expert System, Forward Chaining.

Intisari— Anak dengan Autism Spectrum Disorder (ASD) memerlukan intervensi dini selama tahap perkembangan mereka. Saat ini, ketersediaan tenaga ahli yang mampu mengklasifikasikan tingkat kemandirian anak dengan ASD secara akurat masih terbatas. Penentuan tingkat kemandirian ini sangat penting karena menjadi dasar dalam menetapkan intervensi dini yang tepat. Penelitian ini digunakan untuk membantu para ahli dalam melakukan asesmen secara lebih konsisten dan efisien. Penelitian ini memberikan aplikasi baru dari sistem pakar berbasis forward chaining untuk mengklasifikasikan tingkat kemandirian anak-anak ASD, mengintegrasikan penalaran berbasis aturan dengan evaluasi yang berpusat pada pengguna, yang membedakannya dari studi sebelumnya yang terutama berfokus pada diagnosis daripada penilaian kemandirian fungsional. Data dikumpulkan dari tiga institusi: dua Sekolah Luar Biasa dan satu Unit

Pelaksana Teknis Daerah untuk Anak Berkebutuhan Khusus di Jawa Timur. Dataset terdiri dari 400 rekaman yang mencakup lima aktivitas sehari-hari: makan, minum, gosok gigi, memakai baju, dan melepas baju. Tingkat kemandirian diklasifikasikan ke dalam tiga kategori: mandiri, kurang cukup mandiri, dan kurang mandiri. Penelitian ini terdiri dari tujuh tahap, yaitu pengumpulan data, penyusunan sistem rule base menggunakan forward chaining, perancangan basis data menggunakan CDM dan PDM, pengembangan antarmuka pengguna, implementasi sistem menggunakan framework Next.js dan basis data PostgreSQL, pengujian sistem, serta evaluasi sistem. Hasil penelitian menunjukkan bahwa tingkat akurasi mencapai 98,5% dan skor kepuasan pengguna sebesar 80,85%. Temuan ini menunjukkan bahwa metode yang diusulkan efektif dalam mendukung terapi menentukan tingkat kemandirian anak dengan ASD berdasarkan aturan yang ditetapkan oleh para ahli.

Kata Kunci: *Autisme, Forward Chaining, Kesehatan Anak, Klasifikasi, Sistem Pakar.*

INTRODUCTION

Autism Spectrum Disorder (ASD) is a complex, highly inheritable neurodevelopmental disorder characterized by significant challenges in communication, social interaction, alongside restricted and repetitive behaviors [1], [2]. The prevalence of ASD has been a growing concern worldwide, with the World Health Organization estimating that 1 in 160 children globally are affected [3]. In Indonesia, the rate of ASD diagnoses is reportedly increasing, with hundreds of new cases identified annually, underlining the critical need for effective early interventions. Children with ASD require treatment in the form of early intervention during childhood. The existence of interventions related to training the motor skills provides positive results on the motor skills of children with ASD. These interventions, particularly those focusing on enhancing motor skills, have been demonstrated to substantially improve the autonomy and quality of life for children with ASD [4].

Children with ASD require appropriate interventions and approaches to support the development of greater independence. Ideally, independence should begin to develop before the age of ten [5]. In this context, independence refers to self-care abilities such as eating and drinking, dressing skills including putting on and taking off clothes, and toileting activities, which encompass bathing, toileting, and brushing teeth [6]. Therefore, determining the level of independence of children with ASD is essential for establishing appropriate interventions that can help children with ASD become more independent. However, the limited availability of experts capable of accurately classifying the independence levels of children with ASD poses a significant barrier to providing targeted and appropriate treatment. An expert system is defined as a system designed to solve problems like an expert. An expert system is a knowledge-based system that can produce

conclusions from processing raw data [7]. Forward Chaining is an expert system method for teaching complex sequences of activities. The first step of the activity is taught first, after that each subsequent step is taught. This procedure requires cumulative completion of all previous steps in the correct order until the child can complete all steps in the chain independently. Forward Chaining is suitable for teaching independence to children with ASD who cannot carry out activities independently because it teaches gradual and sequential activities [8].

Previous studies have demonstrated that the forward chaining procedure is effective in developing skills that support independent functioning [9]. The study by [10] also found that expert systems utilizing forward chaining can be used to monitor child development and accurately detect autism levels based on cognitive abilities. Furthermore, the study by [11] reported that expert system software employing forward chaining exhibits excellent usability—covering learnability, efficiency, memorability, error rate, and satisfaction—making it suitable for implementation in operational environments.

However, previous research on ASD has predominantly focused on diagnosis and early detection, with relatively limited studies addressing the assessment of children's independence levels. Moreover, the use of forward chaining-based expert systems in this domain remains underexplored. Therefore, this study proposes the development of a web-based expert system that utilizes a forward chaining method to classify the independence levels of children with ASD. The system aims to address the existing expertise gap by supporting the delivery of more tailored interventions. By integrating expert knowledge into an accessible web-based platform, this approach enhances the decision-making process for therapists and caregivers, ensuring that children with ASD receive interventions that are appropriate to their specific needs. This study not only underscores the urgent need for innovative



solutions in ASD management but also demonstrates the potential of technology to transform treatment and intervention practices in this field.

MATERIALS AND METHODS

This research consists of seven stages, namely data collection, rule base system using forward chaining, database design using Conceptual Data Model (CDM) and Physical Data Model (PDM), user interface development using Figma, system implementation using the Next.js framework and PostgreSQL database, system testing using a black box approach to demonstrate that the system functions correctly according to the predetermined business processes and system evaluation.

Data Collection

Data were obtained from three institutions: two Public Special Need Schools and a Regional Technical Implementation Unit of Children with Special Needs in East Java. Data collection was conducted from January to September 2023. Five categories of self-care activities—eating, drinking, brushing teeth, dressing, and taking off clothes—were assessed. Each child was evaluated on all five activities across four data-collection rounds, yielding 20 observations per participant. In total, 400 activity records were generated from 20 children. Observations were carried out either at home or at school, depending on each child’s routine and institutional arrangements. Self-care performance data for children with ASD were collected using a structured activity-monitoring questionnaire. The instrument comprised sequential task items with closed-ended response options: verbal prompt, gestural prompt, and physical prompt.

Rule Base System

The classification of independence levels was implemented using a forward-chaining rule-based system. The process consisted of three sequential stages: (1) knowledge representation, (2) rule construction, and (3) development of a classification flowchart.

1. Knowledge Representation

Knowledge representation involves organizing information by encoding it into a structured knowledge base. To support independence-level classification, the independence categories and activity sequences are systematically arranged within this framework. The daily activities are presented in Table 1.

Table 1. Daily Activities

No	Activity Code	Activity Name
1	NO1	Eating
2	NO2	drinking,
3	NO3	brushing teeth
4	NO4	dressing
5	NO5	Taking off clothes

Source : (Research Results, 2025)

Each activity listed in Table 1 consists of a sequential activity items. For example, activity coded NO1 (eating) includes steps such as washing hands, preparing food, taking food, praying, eating, and finishing eating. A similar sequence is established for activities coded NO2, NO3, NO4, and NO5. The detailed sequence of these activities is presented in Table 2.

Table 2. Sequential Activity Items

No	Activity Code	Sequential Activity Code	Sequential Activity Name
1	NO1	A01	Washing hands
		A02	Picking up a plate and spoon
		A03	Taking the lunch box
		A04	Preparing the food
		A05	Opening the lunch box
		A06	Reciting a prayer before eating
		A07	Putting the food into the mouth
		A08	Returning the plate and spoon back
		A09	Closing the lunch box
2	NO2	B01	Picking up the glass
		B02	Picking up the bottle
		B03	Pouring the water
		B04	Opening the bottle
		B05	Drinking the water
		B06	Putting the glass back
		B07	Closing the bottle
3	NO3	C01	Picking up the toothbrush
		C02	Picking up the toothpaste
		C03	Taking water for rinsing
		C04	Putting toothpaste on the toothbrush
		C05	Brushing the teeth
		C06	Rinsing the mouth until clean
		C07	Washing the toothbrush
		C08	Returning the toothbrush back
4	NO4	D01	Picking up the shirt
		D02	Putting the head first through the main opening of the shirt
		D03	Putting the arms through the sleeves
		D04	Straightening the shirt
5	NO5	E01	Lifting the shirt up to the chest
		E02	Pulling the shirt over the head
		E03	Taking off the shirt
		E04	Putting the shirt into the laundry basket

Source : (Research Results, 2025)

2. Generated Rule

The independence levels, determined through expert interviews, consist of three categories: independent, partially independent, and dependent, as shown in Table 3. A child is classified as independent when the activity can be completed



with verbal prompts alone; partially independent when completion requires gestural prompts in addition to the verbal prompts; and dependent when the activity can be completed only with the inclusion of physical prompts. According to [12], prompts can be physical, gestural, or verbal. A physical prompt involves hand-over-hand guidance to assist the child in performing the correct action. A gestural prompt uses body movements, such as pointing or hand gestures, to indicate the appropriate action. A verbal prompt provides spoken cues, including instructions, keywords, reminders, or questions.

Table 3. Independence Levels

No	Independence Levels Code	Independence Levels Name
1	TO1	Independent
2	TO2	Partially independent
3	TO3	Dependent

Source : (Research Results, 2025)

To determine the classification results, threshold rules were established. The threshold values used in the classification rules were determined based on a combination of expert knowledge and relevant literature on ASD assessment. A child is classified as dependent when physical prompts constitute more than 70% of interventions; partially independent when gestural prompts exceed 70% or when both physical and verbal prompts are below 70%; and independent when verbal prompts exceed 70% [13]. The threshold rules are summarized in Table 4.

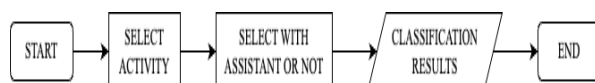
Table 4. Threshold Rules

No	Independence Levels Code	Threshold Rules
1	TO1	Physical Prompt > 70%
2	TO2	Gestural Prompt >= 70% OR (Physical Prompt <= 70% AND Verbal Prompt <= 70%)
3	TO3	Verbal Prompt > 70%

Source : (Research Results, 2025)

3. Classification Flowchart

This phase focused on the application of the forward chaining methodology to systematically assess and classify the independence levels of children with ASD based on their ability to perform the specified activities. The process flow is illustrated in the system flowchart shown in Fig. 1.



Source : (Research Results, 2025)

Figure 1. Classification Flowchart

Database Design

The CDM was developed to define relationships among data-driven Change Management (CM) categories and was subsequently validated. Existing studies have proposed data models for Engineering Change in manufacturing; however, they typically focus on a single CM strategy [14]. The PDM represents the implementation of a database structure within a database management system, translating the logical model into storage structures, indexing, and physical data representation. Integrating both logical and physical levels ensures a comprehensive database design that meets conceptual and technical requirements [15].

User Interface Development

Web design is a rapidly evolving field within the technology industry, driven by digital transformation and the growing adoption of web-based applications. Designers increasingly seek tools that enable immersive and user-centered design experiences. Figma is a distinctive web-based design tool that enhances accessibility, collaboration, and overall design capabilities [16]. Figma is accessible anytime via the internet and available on Windows and macOS, offering rapid prototyping capabilities and strong collaboration features for team-based design [17].

System Implementation

PostgreSQL is an open-source database system that has undergone more than 15 years of active development and has established a proven record of accomplishment through its robust architectural design. It is widely recognized for its reliability, data integrity, and accuracy [18]. PostgreSQL is freely distributed under the BSD license, making it one of the most widely used database systems alongside MySQL and Oracle. As an open-source platform, PostgreSQL can be used without licensing violations, allowing unrestricted public access and deployment [19].

Next.js enhances the React.js development experience by providing production-ready features such as server-side rendering, TypeScript support, intelligent bundling, and file-based routing. It also offers hot code reloading, automatic routing, component-scoped styling with styled-JSX, and dynamic loading of JavaScript modules and React components. These capabilities, along with its support for static site generation, enable efficient and high-performance web application development [20].

System Testing

In black-box testing, the application is evaluated in detail based on its interface, available functionalities, and the alignment of functional workflows with the business processes defined by the users. This testing approach primarily focuses on assessing the user interface to ensure ease of use and functionality accuracy [21]. Several black-box testing techniques are commonly employed:

1. Equivalence Partitioning – This technique partitions input data into distinct classes to reduce redundant test cases while ensuring adequate coverage.
2. Boundary Value Analysis – This method focuses on testing values at the boundaries of input ranges, where errors are most likely to occur.
3. Fuzzing – A semi-automated technique used to detect software bugs by injecting invalid, unexpected, or random data into the system.
4. Cause-Effect Graphing – A graphical technique that illustrates the relationships between potential causes of errors and their effects.
5. Orthogonal Array Testing – Suitable for scenarios with a relatively small input domain, providing efficient test coverage through systematic sampling of combinations.
6. All-Pairs Testing – Ensures that all possible pairs of input parameter combinations are tested, minimizing the number of test cases while maintaining coverage.
7. State Transition Testing – Useful for evaluating system behavior through various states and verifying user interface navigation based on defined state transitions.

System Evaluation

System evaluation was carried out by comparing the system’s diagnostic results with those provided by experts. The purpose of this evaluation was to measure the system’s accuracy in classifying the independence levels of children with ASD. Accuracy was determined by assessing the degree of agreement between the system-generated classifications and expert classifications. In addition, a functional evaluation was conducted using a questionnaire designed based on user requirements.

The questionnaire involved two groups of respondents: the first group consisted of three experts—teachers and therapists from two Public Special Need Schools and a Regional Technical Implementation Unit of Children with Special Needs in East Java —while the second group consisted of five parents of children with ASD.

RESULTS AND DISCUSSION

Data Collection

The data were collected through questionnaires. 237 records were categorized as dependent, 151 as partially independent, and 12 as independent. A detailed summary of data is presented in Table 5.

Table 5. Summary of Data

Activity	Independence Levels Name	Number
Eating	Independent	50
	Partially independent	29
	Dependent	1
Drinking	Independent	47
	Partially independent	28
	Dependent	5
Brushing teeth	Independent	46
	Partially independent	34
	Dependent	0
, Dressing,	Independent	45
	Partially independent	33
	Dependent	2
Taking off clothes	Independent	49
	Partially independent	27
	Dependent	4
Total		400

Source : (Research Results, 2025)

Rule Base System

Based on Tables 1 and 2, an inference engine was developed using a rule-based approach grounded in independence skills to implement the forward chaining method. The facts presented in the tables were combined with expert-defined rules to generate classification outcomes. The rules were assigned codes based on the activity category: Z for eating, Y for drinking, X for tooth brushing, W for dressing, and V for taking off clothes. When a fact matched the premise of a given rule, the inference process advanced to the next corresponding premise. Tables 6 through 10 present the complete rule sets for each self-care activity. For every activity type, the final rule directs the system to an independence classification outcome, determined according to the threshold criteria specified in Table 4.

Table 6. Rule Set for the Eating Activity

Rule Code	Rule
Z1	IF A01 = TRUE AND A02 = TRUE THEN Preparing to Eat = TRUE
Z2	IF A01 = TRUE AND A03 = TRUE THEN Preparing to Eat = TRUE
Z3	IF Preparing to Eat = TRUE AND A04 = TRUE AND A06 = TRUE THEN Before Eating = TRUE
Z4	IF Preparing to Eat = TRUE AND A05 = TRUE AND A06 = TRUE THEN Before Eating = TRUE
Z5	IF Before Eating = TRUE AND A07 = TRUE THEN Eating = TRUE

Rule Code	Rule
Z6	IF Eating = TRUE AND A08 = TRUE THEN Finished Eating = TRUE
Z7	IF Eating = TRUE AND A09 = TRUE THEN Finished Eating
Z8	IF Finished Eating = TRUE THEN Displaying Classification Result

Source : (Research Results, 2025)

Table 7. Rule Set for the Drinking Activity

Rule Code	Rule
Y1	IF B01 = TRUE THEN Preparing to Drink = TRUE
Y2	IF B02 = TRUE THEN Preparing to Drink = TRUE
Y3	IF Preparing to Drink = TRUE AND B03 = TRUE THEN Before Drinking = TRUE
Y4	IF Preparing to Drink = TRUE AND B04 = TRUE THEN Before Drinking = TRUE
Y5	IF Before Drinking = TRUE AND B05 = TRUE THEN Drinking = TRUE
Y6	IF Drinking = TRUE AND B06 = TRUE THEN Finished Drinking = TRUE
Y7	IF Drinking = TRUE AND B07 = TRUE THEN Finished Drinking
Y8	IF Finished Drinking = TRUE THEN Displaying Classification Result

Source : (Research Results, 2025)

Table 8. Rule Set for the Brushing Teeth Activity

Rule Code	Rule
X1	IF C01 = TRUE AND C02 = TRUE AND C03 = TRUE THEN Preparing to Brush the Teeth = TRUE
X2	IF Preparing to Brush the Teeth = TRUE AND C04 THEN Before Brushing the Teeth = TRUE
X3	IF Before Brushing the Teeth = TRUE AND C05 = TRUE AND C06 = TRUE THEN Brushing the Teeth = TRUE
X4	IF Brushing the Teeth = TRUE AND C07 = TRUE AND C08 = TRUE THEN Finished Brushing the Teeth = TRUE

Rule Code	Rule
X5	IF Finished Brushing the Teeth = TRUE THEN Displaying Classification Result

Source : (Research Results, 2025)

Table 9. Rule Set for the Dressing Activity

Rule Code	Rule
W1	IF D01 = TRUE THEN Preparing to Wear Clothes = TRUE
W2	IF Preparing to Wear Clothes = TRUE AND D02 = TRUE AND D03 = TRUE THEN Wearing Clothes = TRUE
W3	IF Wearing Clothes = TRUE AND D04 = TRUE THEN Finished Wearing Clothes = TRUE
W4	IF Finished Wearing Clothes = TRUE THEN Displaying Classification Result

Source : (Research Results, 2025)

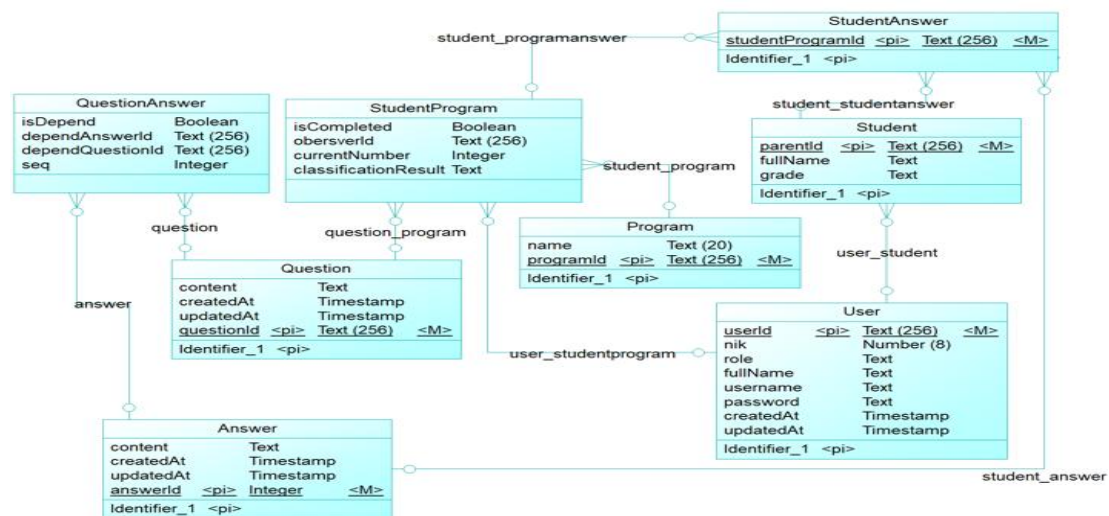
Table 10. Rule Set for the Taking off Clothes Activity

Rule Code	Rule
V1	IF E01 = TRUE THEN Preparing to Take Off Clothes = TRUE
V2	IF Preparing to Take Off Clothes = TRUE AND E02 = TRUE AND E03 = TRUE THEN Taking Off Clothes = TRUE
V3	IF Taking Off Clothes = TRUE AND E04 = TRUE THEN Finished Taking off Clothes = TRUE
V4	IF Finished Taking off Clothes = TRUE THEN Displaying Classification Result

Source : (Research Results, 2025)

Database Design

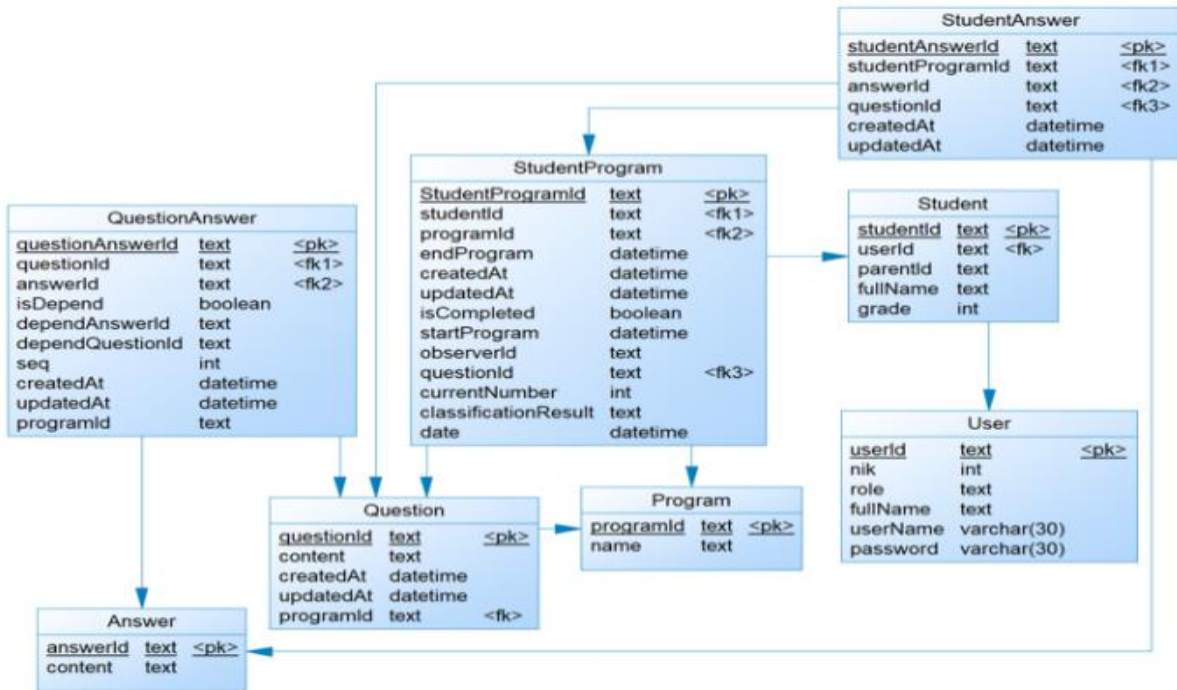
The system design consisted of two components: the development of the database structure and the design of the user interface. Power Designer was used to construct the CDM (Figure 2) and the PDM (Figure 3).



Source : (Research Results, 2025)

Figure 2 . Conceptual Data Model



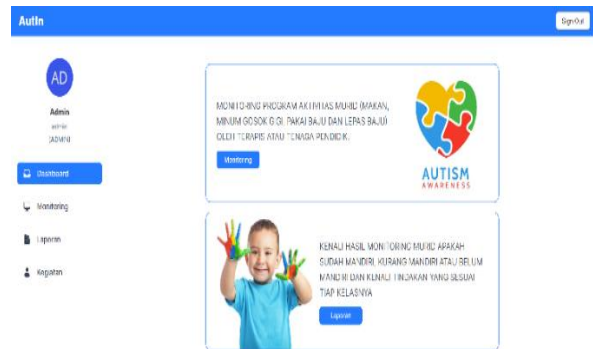


Source : (Research Results, 2025)

Figure 3. Physical Data Model

System Implementation

Based on the previously completed design, the developed system comprised 22 web pages, all of which were implemented using Next.js. The following figures present selected interfaces from the system implementation. Figure 4 presents the initial page displayed when a user accesses the system, which contains a brief description of the application. After successfully logging in, the user is directed to the dashboard page, as shown in Figure 5. To perform monitoring, the user can access the monitoring menu shown in Figure 6. From this page, the user can input the monitoring results for a selected activity.



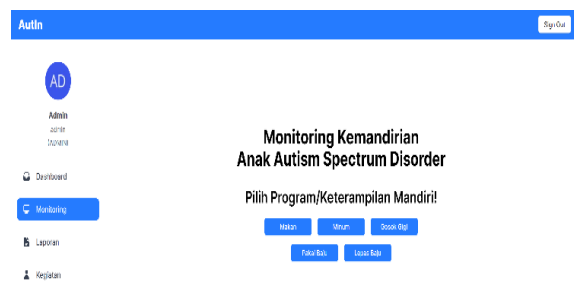
Source : (Research Results, 2025)

Figure 5. Dashboard Page



Source : (Research Results, 2025)

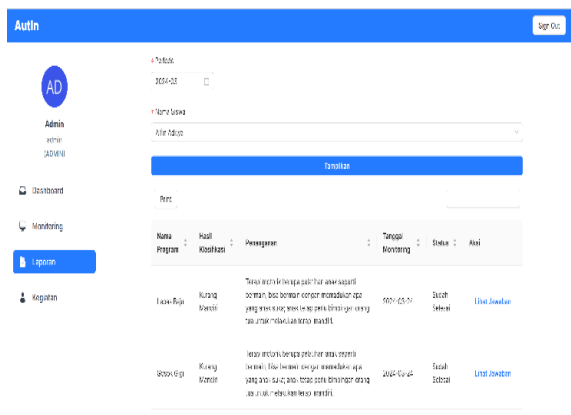
Figure 4. Home Page



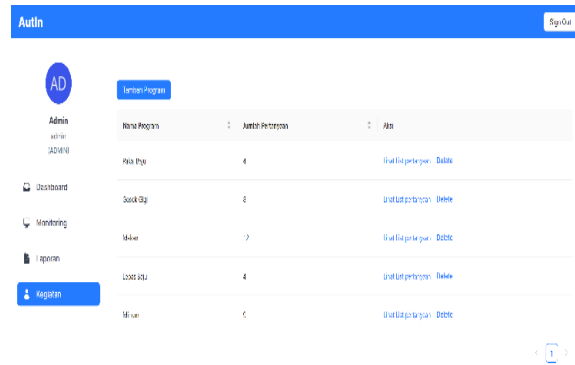
Source : (Research Results, 2025)

Figure 6. Monitoring Page

The results of monitoring activities can be viewed on the report page shown in Figure 7. In addition, the administrator can configure which activities are to be recorded and define the questions used to monitor those activities. Figure 8 presents the page for configuring activity-specific monitoring questions.



Source : (Research Results, 2025)
 Figure 7. Report Page



Source : (Research Results, 2025)
 Figure 8. Activity Page

System Testing

Black-box testing was conducted by two university students and two experts, who evaluated whether the system operated according to the expected outcomes. The result of black-box testing are presented in Table 11.

Table 11. Result of Black Box Testing

Function	Test Method	Expected Result	System Response				Test Result			
			S1	S2	E1	E2	S1	S2	E1	E2
Login	Inserting username and password	Proceeding to system dashboard	P	P	P	P	M	M	M	M
Register	Inserting personal data, username, and password	Back to system login page	P	P	P	P	M	M	M	M
Logout	Clicking logout button	Back to system login page	P	P	P	P	M	M	M	M
CRUD Activity	Creating, updating, and deleting activity	Activity log updated	P	P	P	P	M	M	M	M
Monitoring	Clicking help button	System showing monitoring page	P	P	P	P	M	M	M	M
Report	Clicking report option	System showing monthly or yearly monitoring result	P	P	P	P	M	M	M	M
History	Clicking answers history	System is showing recorded response box	P	P	P	P	M	M	M	M

Source : (Research Results, 2025)

The two students (S1 and S2) and the two experts (E1 and E2) provided satisfactory evaluations, as shown in Figure 2. In the assessment, “P” indicates *Pass* for the system response test, and “M” indicates *Match*, signifying that the system met the expected results. The implementation of the forward-chaining inference mechanism in the independence-level classification system for children with ASD functioned as intended within the defined business process framework.

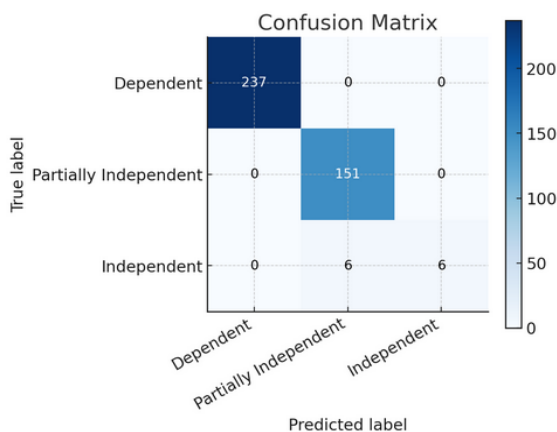
System Evaluation

The evaluation was performed by calculating the system’s accuracy to assess its performance relative to the applied method. This accuracy assessment involved comparing the expert system’s output with the results obtained from expert monitoring. In addition, a functional evaluation was conducted using a questionnaire developed based on user requirements. This evaluation aimed to gather user feedback on the system’s interface, functionalities, and overall features.



Expert Monitoring Results

Expert monitoring data showed that, among the assessed children, 237 were classified as *dependent*, 151 as *partially independent*, and 12 as *independent*. Based on the system evaluation, 394 out of 400 data records produced classifications that matched the expert assessments. A discrepancy was found in six cases, where children classified as independent by experts were categorized as partially independent by the system. This misclassification may be attributed to the similarity between verbal prompts and physical prompts, which makes them difficult to distinguish. Additionally, gestures in children with ASD are often ambiguous, inconsistent, and highly variable across individuals, making accurate interpretation challenging-even for experienced observers [22]. The classification performance of the proposed system, as illustrated by the confusion matrix, is shown in Figure 9.



Source : (Research Results, 2025)

Figure 9. Confusion Matrix

Accuracy was calculated by dividing the number of matching classifications by the total number of records and multiplying the result by 100%. Overall, the forward-chaining-based expert system achieved an accuracy rate of 98.5% across the 400 samples.

Satisfaction Questionnaire Results

The system was also evaluated using a questionnaire administered to two experts and two parents. The questionnaire consisted of five response options: 1 (*Strongly Disagree*), 2 (*Disagree*), 3 (*Undecided*), 4 (*Agree*), and 5 (*Strongly Agree*) [23]. The satisfaction results are presented in Table 11. The total score obtained from the user evaluation was divided by the maximum possible score to generate a percentage value. The final score was categorized as *very bad* for intervals of 0–

24.9%, *poor* for 25–49.9%, *good* for 50–74.9%, and *very good* for 75–100%.

Table 12. Satisfaction Questionnaire Results

Topic	Answers	Score	No. of Respondents	Total Score	Expected Score
Wieldiness	Strongly Agree	5	1	29	35
	Agree	4	6		
Interactivity	Strongly Agree	5	2	28	35
	Agree	4	4		
	Disagree	2	1		
Navigation	Agree	4	6	27	35
	Uncertain	3	1		
Appearance	Strongly Agree	5	1	29	35
	Agree	4	6		
Features	Agree	4	6	27	35
	Uncertain	3	1		
Language	Agree	4	6	27	35
	Uncertain	3	1		
Informative	Strongly Agree	5	1	29	35
	Agree	4	6		
Information Detail	Strongly Agree	5	2	30	35
	Agree	4	5		
Overall	Agree	4	7	28	35
Appearance User Expectation	Strongly Agree	5	1	29	35
	Agree	4	6		
	Agree	4	6		
Total Score				283	350
Average Score				80.85%	

Source : (Research Results, 2025)

Table 12 shows that the system received an average satisfaction score of 80.85%, placing it in the *very good* category with a performance indicator above 75%. This result indicates the usefulness and effectiveness of the expert system in supporting therapists in monitoring the independence of children with ASD. Respondent feedback also identified areas for improvement, particularly suggesting that the parent dashboard should avoid adopting an interface design similar to that used for administrators and therapists.

CONCLUSION

This study demonstrates the critical importance of early intervention in managing ASD through a web-based expert system utilizing a forward-chaining methodology. The design and implementation of the system streamline the classification of independence levels in children with ASD, thereby supporting more tailored and

effective intervention planning. Data collected from multiple educational institutions revealed meaningful distributions across independence categories—-independent, partially independent, and dependent—providing valuable insight into children’s functional abilities.

The system’s performance was validated through black-box testing, achieving an accuracy of 98.5% and a user satisfaction score of 80.85%. These results affirm the potential of the proposed expert system as a practical tool for therapists, enabling a structured and consistent assessment process to enhance the independence skills of children with ASD. This research contributes to the field by introducing a systematic decision-support solution that addresses gaps in expert availability and promotes early, individualized intervention. Nevertheless, several limitations present opportunities for future development. The current system is limited to a web-based platform; subsequent work may extend implementation to mobile or desktop applications to increase accessibility and usability. Additionally, future studies may explore alternative inference techniques, such as backward chaining, certainty factors, or hybrid expert-system approaches, to further improve classification accuracy and system robustness.

REFERENCE

- [1] Y. Li, "Global autism prevalence, and exploring Montessori as a practical educational solution: a systematic review," *Frontiers in psychiatry*, vol. 16, 2025, doi: 10.3389/fpsy.2025.1604937.
- [2] L. Qin, H. Wang, W. Ning, M. Cui, and Q. Wang, "New advances in the diagnosis and treatment of autism spectrum disorders," *European Journal of Medical Research*, vol. 29, no. 1, 2024, doi: 10.1186/s40001-024-01916-2.
- [3] N. Daulay, H. Daulay, and F. Rohman, "Religious coping of Muslim mothers of children with autism spectrum disorder in Indonesia," *Journal of Disability & Religion*, vol. 29, no. 1, pp. 33-50, 2025, doi: 10.1080/23312521.2024.2372021.
- [4] W. Zheng, "Implicit motor learning in children with autism spectrum disorder: current approaches and future directions," *Frontiers in Psychiatry*, vol 15, 2024, doi: 10.3389/fpsy.2024.1253199.
- [5] D. U. Reddy, K. V. P. Kumar, B. Ramakrishna, and U. G. Sankar, "Adaptive Tactile Therapy System for Children with Autism Spectrum Disorder," *In International Conference on Paradigm Shifts in Communication, Embedded Systems, Machine Learning and Signal Processing*, vol. November, pp. 47-57, 2024, doi: 10.1007/978-3-031-90580-3_4.
- [6] C. Gal and C. H. Ryder, "Structured teaching to promote hygiene skill development in children with autism: a multi-context case study," *International Journal of Developmental Disabilities*, vol. Aug, pp. 1-16, 2025, doi: 10.1080/20473869.2025.2545957.
- [7] T. Babu, R. Nair, P. V. Rayar, and B. M. Poornima, "Forward Chaining in Expert Systems: Application to Medical Diagnosis," *International Conference on Computing for Sustainable Global Development (INDIACom)*, 2025, doi: 10.23919/INDIACom66777.2025.11115628.
- [8] T. M. Minolin, R. Avinash, P. Thenmozhi, S. Tamilselvi, and G. Bhuvanewari, "To Assess the Effectiveness of Forward Chaining Technique on Dressing Skills among Mentally Retarded Children at Kiruba Nursing Home," *Texila International Journal of Public Health*, vol. 12, no. 4, 2024, doi: 10.21522/TIJPH.2013.12.04.Art005.
- [9] A. Bojana, A. Gajic, A. Basic, and D. Macesic-Petrovic, "Teaching Shoelace Tying to A Child with Autism Spectrum Disorder," *Research in Education and Rehabilitation*, vol 4, no. 2, pp. 181-188, 2021, doi: 10.51558/2744-1555.2021.4.2.181.
- [10] G. W. Dairoh, G. Sasmito, and Raharjo, "Implementation of an expert system in diagnosing children's mental disorders using the forward chaining method," *In 3rd Borobudur International Symposium on Science and Technology, AIP Publishing LLC*, vol. 2706, No. 1, pp. 020012, 2023, doi: 10.1063/5.0120398.
- [11] Munir, R. N. Kaosar, Rasim, I. Murtadha, F. Shahbodin, and I. S. Riza, "Expert System Using the Educational Game to Determine Children's Autism Levels Using Forward Chaining," *Linguistics and Culture Review*, vol. 5, no. S1, pp. 1149-1172, 2021, doi: 10.21744/lingcure.v5nS1.1499.
- [12] J. D. Benson, A. Cartwright, K. A. Szucs, D. Smitsky, E. Chippich, and L. Roebuck, "Effectiveness of video prompting versus picture prompting in improving daily living skills of autistic children," *The American Journal of Occupational Therapy*, vol. 78, no. 3, 2024, doi: 10.5014/ajot.2024.050514.



- [13] R. Bosley, S. J. Loveall, K. K. Kellum, and K. Hawthorne, "RECALL prompting hierarchy improves responsiveness for autistic children and children with language delay: a single-case design study," *Frontiers in Psychology*, vol. 15, 2024, doi: 10.3389/fpsyg.2024.1435688.
- [14] F. Acerbi, C. Sassanelli, and M. Taisch, "A conceptual data model promoting data-driven circular manufacturing," *Operations Management Research*, vol. 15, no. 3, pp. 838-857, 2022, doi: 10.1007/s12063-022-00271-x.
- [15] F. Mostajabi, A. A. Safaei, and A. Sahafi, "A systematic review of data models for the big data problem," *IEEE Access*, vol. 9, pp. 128889-128904, 2021, doi: 10.1109/ACCESS.2021.3112880.
- [16] H. Hariyadi, H. Yamashika, W. Mustaqim, A. Alfirdaus, M. Giatman, and R. Risfendra, "Mobile application design for learning digital engineering based on figma and android studio," *Journal of Computer Science, Information Technology and Telecommunication Engineering*, vol. 4, no. 1, pp. 370-376, 2023, doi: 10.30596/jcositte.v4i1.13184.
- [17] N. Mustika, M. Mirfan, A. M. A. K. Parewe, and T. T. Layuk, "Designing the user interface for the virtual tour Selayar system using Figma," *Brilliance: Research of Artificial Intelligence*, vol. 4, no. 2, pp. 478-483, 2024, doi: 10.47709/brilliance.v4i2.4587.
- [18] S. V. Salunke and A. Ouda, "A performance benchmark for the postgresql and mysql databases," *Future Internet*, vol. 16, no. 10, 2024, doi: 10.3390/fi16100382.
- [19] M. Natti, "Migrating from oracle to postgresql: Leveraging open-source to reduce database costs and enhance flexibility," *The Eastasouth Journal of Information System and Computer Science*, vol. 1, no. 02, pp. 109-112 2023, doi: 10.58812/esiscs.v1i02.433.
- [20] V. Patel, "Analyzing the impact of Next. JS on site performance and SEO," *International Journal of Computer Applications Technology and Research*, vol. 12, no. 10, pp. 24-27, 2023, doi: 10.7753/IJCATR1210.100.
- [21] Z. Aghababaeyan, M. Abdellatif, L. Briand, and M. Bagherzadeh, "Black-box testing of deep neural networks through test case diversity," *IEEE Transactions on Software Engineering*, vol. 49, no. 5, pp. 3182-3204, 2023, doi: 10.1109/TSE.2023.3243522.
- [22] M. G. Logrieco, E. Annechini, L. Casula, S. Guerrero, M. Fasolo, S. Vicari, and G. Valeri. "Nonverbal Skills Evolution in Children with Autism Spectrum Disorder One-Year Post-Diagnosis," *Children*, vol. 11, no. 12, 2024. doi: 10.3390/children11121520.
- [23] B. Tanujaya, R. C. I. Prahmana, and J. Mumu, "Likert Scale in Social Sciences Research: Problems and Difficulties," *FWU Journal of Social Sciences*, vol 16, no. 4, pp. 89-101, 2022, doi: 10.51709/19951272/Winter2022/7.