



Expert System for Diagnosing Indihome Network Connection Disorders Using Metode Backward Chaining (Case Study: Telkom Jayapura City)

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Abstract: In the rapidly advancing digital era, reliable internet connectivity has become a fundamental necessity for both individuals and organizations, facilitating various aspects of daily operations. However, technical issues in the network can lead to significant disruptions, adversely affecting productivity and user experience. PT Telkom Access (PTTA) Papua, a subsidiary responsible for managing network infrastructure, often encounters challenges in resolving customer complaints efficiently. A primary issue is the insufficient and vague information provided by customers, which hinders the diagnostic process and prolongs the resolution time. To address this problem, this study proposes the development of an expert system employing the backward chaining method. This system is designed to analyze the symptoms reported by customers and generate precise diagnostic solutions. In addition to offering accurate problem-solving capabilities, the system also aims to improve customer understanding through targeted educational tools, ensuring that essential components are readily available on-site to expedite the repair process. Comprehensive testing of the system has confirmed that all functionalities operate as expected. Consequently, this expert system is projected to significantly enhance customer satisfaction, improve the efficiency of issue resolution, and elevate the overall service quality provided by PTTA Papua.

Keywords: Expert System; Backward Chaining; IndiHome; Network Diagnosis; PT Telkom Access.

1. Introduction

In the current digital era, internet connectivity has become a fundamental necessity for both individuals and organizations [1][2]. As reliance on the internet network grows, the reliability and quality of service become critical factors influencing user experience [3]. However, technical issues within the network often disrupt daily activities, causing discomfort and other negative impacts. PT Telkom Access (PTTA) Papua, a subsidiary of PT Telekomunikasi Indonesia, Tbk (Telkom), wholly owned by Telkom, is engaged in providing construction services and managing network infrastructure, including performing network maintenance for customers. Customers can contact 147 to report network issues to the central PT Telekomunikasi Indonesia, Tbk (Telkom), and in February and March 2023, there were 279 reports from IndiHome consumers in Jayapura City. These reports are forwarded to PTTA Papua for further processing.

A significant challenge in network issue resolution arises from the insufficient understanding customers often have when describing the problems they encounter. For example, a customer might report an issue with their home internet connection without providing specific details about the location or nature of the problem. Upon arriving at the site, technicians might discover that the issue is minor and could have been resolved independently by the customer. The lack of detailed information can lead to uncertainty when diagnosing the problem and determining whether a device needs to be replaced. It often turns out that, based on vague information, unnecessary replacements are recommended due to the customer's limited understanding of the symptoms. Of the 279 reports received, only 137, or about 49%, mentioned router/modem issues with symptoms like the Loss of Signal (LOS) light not turning on. When resolving these issues requires additional items not available at the location, technicians must return to the PTTA Papua office to retrieve the necessary items. This process can delay problem resolution and negatively impact the performance of field technicians.

To address these challenges, there is a need for a computer-based intelligent system, specifically an expert system, to assist in resolving these issues. The expert system to be developed in this context employs the backward chaining method, as this method focuses on analyzing the sequence of symptoms in a rule-based system [4]. Implementing a backward chaining approach can provide an effective solution to the problem of inadequate customer information when reporting network issues. First, it is necessary to enhance customer understanding through educational programs that emphasize the importance of reporting key details such as the location and nature of the problem. With this approach, field technicians can obtain the necessary information more quickly before arriving at the site. Additionally, an on-site fulfillment policy can be implemented to ensure that technicians frequently carry the necessary items, reducing the need to return to the office. These steps are expected to make the process of resolving network issues more efficient and effective.

Based on the above considerations, the proposed research IndiHome Network Connection Disorder Diagnosis Expert System Using the Backward Chaining Method. The objective of developing this expert system is to enhance the capability of handling network issues experienced by customers. The benefits of this system are expected to include improved customer satisfaction, increased efficiency in handling time, and better communication quality, all of which contribute to enhancing the overall quality of service. The data used in this system includes 11 categories of damage and 40 categories of symptoms. With the implementation of this expert system, PTTA Papua is expected to improve its performance in addressing the network issues reported by customers. The system not only serves as a tool for more accurate diagnosis but also as an educational resource for customers, helping them provide more detailed and accurate information when reporting issues. The on-site fulfillment policy is anticipated to reduce resolution times and increase operational efficiency. Overall, the development of this expert system is expected to make a significant positive contribution to the quality of service and customer satisfaction at PTTA Papua.

2. Research Method

This research plan focuses on applying the waterfall development method at PT Telkom Access (PTTA) Papua. The research process encompasses several key phases, namely system requirements analysis, system design, coding, and testing [5][6]. The waterfall method is a linear and sequential approach, where each phase depends on the deliverables of the previous one and corresponds to a specialization of tasks.

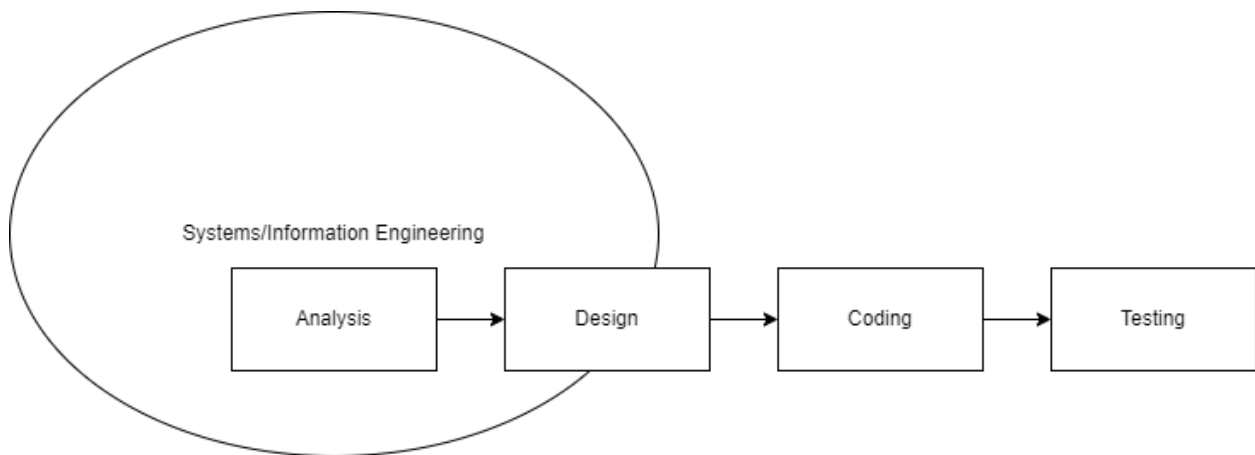


Figure 1. Waterfall Method

2.1 System Requirements Analysis

The analysis of system requirements at PT Telkom Access (PTTA) Papua has revealed that a major challenge lies in the customers' lack of understanding when reporting network issues. Often, the information provided is minimal, particularly concerning the problem's location or nature. This lack of detailed reporting complicates the troubleshooting process for field officers, who may encounter straightforward problems that are escalated due to vague descriptions. The consequence is a delay in problem resolution, as officers may need to spend additional time diagnosing issues that could have been clearly communicated [7].

2.2 System Design

The system design phase utilizes structured methodologies, including context diagrams, tiered diagrams, and overview diagrams, to ensure a clear and organized representation of the system architecture [8]. The database design is executed using the Entity Relationship Diagram (ERD) approach, which provides a visual representation of the system's data model, including entities, relationships, and attributes. This structured design phase is critical in laying the groundwork for the subsequent coding phase, ensuring that all system components are well-defined and interconnected.

2.3 Coding

In the coding phase, the system design is translated into a functional application using the Hypertext Preprocessor (PHP) programming language [10]. PHP is chosen due to its effectiveness in developing dynamic web applications, which is essential for creating an interactive expert system. This phase involves implementing the designed features, ensuring that the system's logic, data handling, and user interfaces are coded accurately according to the specifications outlined during the design phase.

2.4 Testing

After the system has been coded, it undergoes rigorous testing using the black box testing method. This testing approach focuses on evaluating the functionality of the system without delving into the internal code structure. The primary goal is to identify and rectify errors (bugs) that could affect the system's performance. The black box testing method is particularly effective in validating the system's input and output, ensuring that the system behaves as expected under various scenarios [11].

2.5. Data Analysis

Data analysis within the expert system is managed through the categorization of symptom data, damage data, and the knowledge base. These categories form the foundation of the diagnostic process, where the system correlates symptoms reported by customers with possible causes, based on predefined rules.

Table 1. Symptoms

No	Code	Symptom
1	G01	Interruption or loss of connection
2	G02	Network performance degradation
3	G03	Decrease in the number of signals
4	G04	Deterioration in video or audio signal quality

5	G05	Interference with data transmission
6	G06	Decrease in light intensity (in optical fibers)
7	G07	Increased heat in cables
8	G08	Deterioration in signal quality
9	G09	Sync failure
10	G10	Overheating of adapter/modem
11	G11	All lights on the device will not turn on, or turn off
12	G12	Only power, PON, and LOS lights cannot be turned on
13	G13	Interference in optical signals
14	G14	Decrease in network power on other network resources
15	G15	Environmental influences
16	G16	Physical condition of cables or connectors
17	G17	Overheating of router or modem devices
18	G18	Limited capabilities on new standards
19	G19	Worn or damaged physical appearance
20	G20	No display on TV screen
21	G21	No signal or weak signal
22	G22	Indicator light off setup box/STB
23	G23	Does not respond to remote control
24	G24	Software or firmware is not up to date
25	G25	Regional or service restrictions
26	G26	Technological limitations of IndiHome devices
27	G27	Problems with the application
28	G28	No Wi-Fi signal
29	G29	Can't find Wi-Fi network
30	G30	Wi-Fi indicator light off
31	G31	Internet indicator light off
32	G32	Device not connected to network
33	G33	Inability to access cloud or external servers
34	G34	Error messages on connected devices
35	G35	Pound light off or not on
36	G36	PON light slow blink
37	G37	PON light flashing fast or specific pattern
38	G38	PON lamp flashes alternately with other colors
39	G39	PON lamp flashes according to a specific code pattern
40	G40	PON light flashes once or temporarily

Table 2. Damage

No	Code	Damage
1	K01	Damage to the optical cable
2	K02	Damage to the clear Indoor Cable
3	K03	Damage to the optical adapter/connector between the eye ends of the optical cable
4	K04	Router/modem malfunction
5	K05	Attenuation, or abnormal optical network power on the router/modem
6	K06	Routers/modems that have been in use for more than three years
7	K07	Setup Box/STB is completely dead
8	K08	Does not support the latest applications subscribed to IndiHome
9	K09	The router/modem is off or not turning on
10	K10	The internet light on the router/modem is off or cannot turn on
11	K11	PON light on router/modem, turns off, or flashes

Table 3. Knowledge Base

No	Crash Code	Symptomatic Rules
1	K01	IF K01 THEN G01 AND G02 AND G03 AND G04
2	K02	IF K02 THEN G01 AND G05 AND G06 AND G07
3	K03	IF K03 THEN G01 AND G08 AND G09 AND G10
4	K04	IF K04 THEN G011 AND G012

5	K05	IF K05 THEN G02 AND G09 AND G13 AND G14 AND G15 AND G16 AND G17
6	K06	IF K06 THEN G02 AND G10 AND G18 AND G19
7	K07	IF K07 THEN G20 AND G21 AND G22 AND G23
8	K08	IF K08 THEN G24 AND G25 AND G26 AND G27
9	K09	IF K09 THEN G01 AND G28 AND G29 AND G30
10	K10	IF K10 THEN G01 AND G31 AND G32 AND G33 AND G34
11	K11	IF K11 THEN G35 AND G36 AND G37 AND G38 AND G39 AND G40

These tables form the core of the expert system, where the system identifies potential issues based on the symptoms reported by customers and suggests appropriate actions or repairs, guided by the established symptomatic rules. This structured approach ensures that field officers are equipped with accurate and actionable information, improving the efficiency of problem resolution.

3. Result and Discussion

3.1 Results

This section outlines the research flow utilizing the backward chaining method based on the analyzed data, which is compiled into a decision tree. The decision tree serves as a visual representation of the logical flow in diagnosing and resolving network issues based on the symptoms provided. Please refer to Figure 2 to view the formed decision tree.

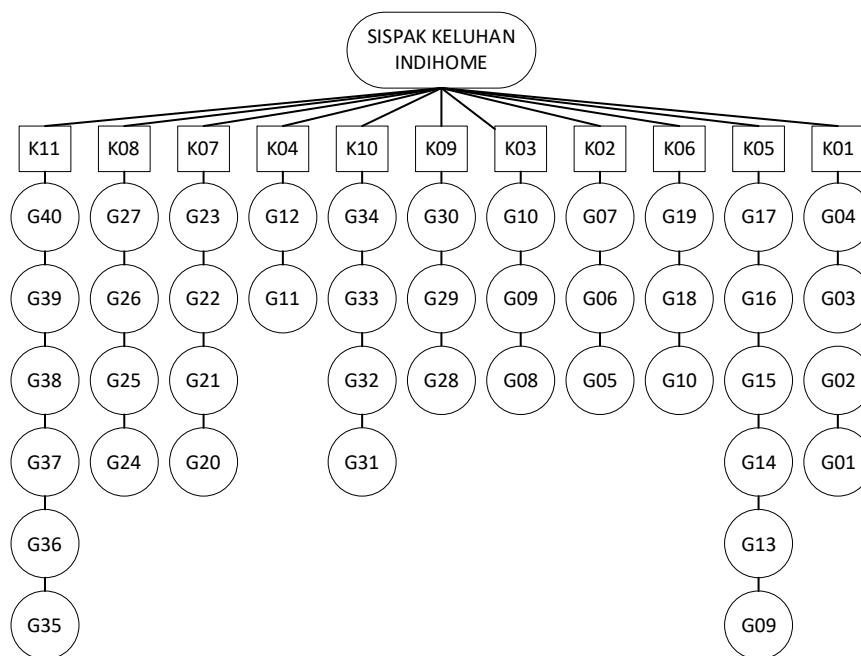


Figure 2. Decision Tree

3.1.1 System Planning

The system design for this expert system is developed using a structured design approach. This includes the use of context diagrams and overview diagrams to illustrate the overall system architecture. The database design is scaffolded using an Entity Relationship Diagram (ERD), which provides a detailed view of the data structure and relationships within the system.

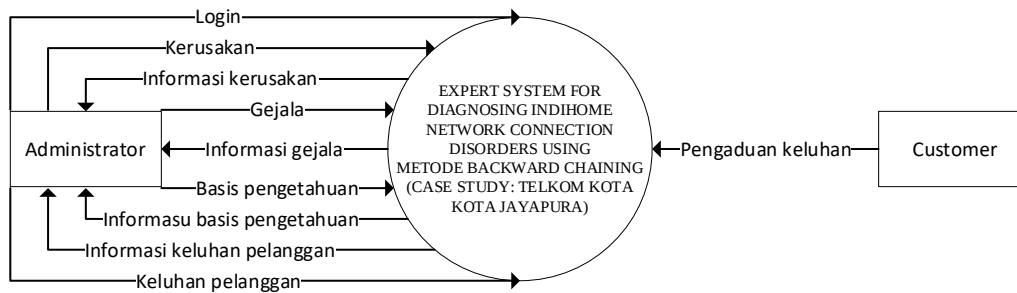


Figure 3. Context Diagram

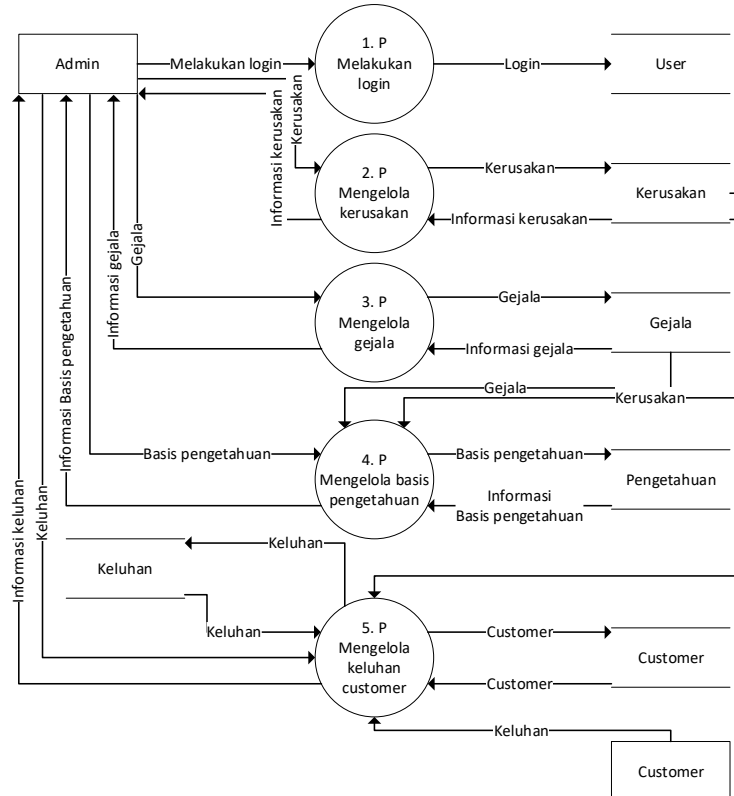


Figure 4. Overview Diagram

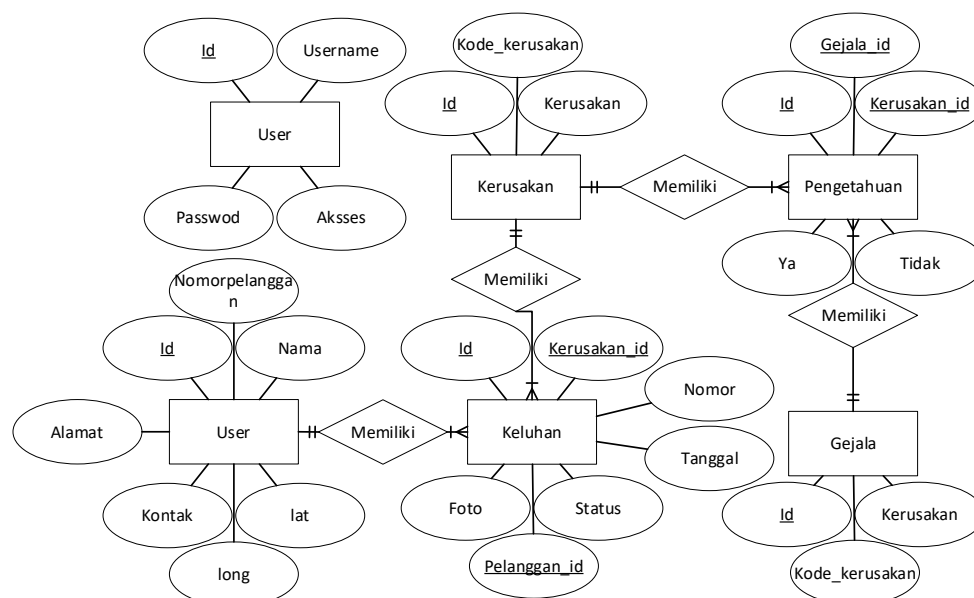


Figure 5. Entity Relationship Diagram

3.1.3 Implementation

Figure 6 illustrates the interface page designed for managing crash data. The page is divided into two main sections: on the left, an input form allows users to add or modify crash data, while the right side displays the already added data. This section also includes buttons for changing, deleting, and managing the knowledge base associated with the crash data.

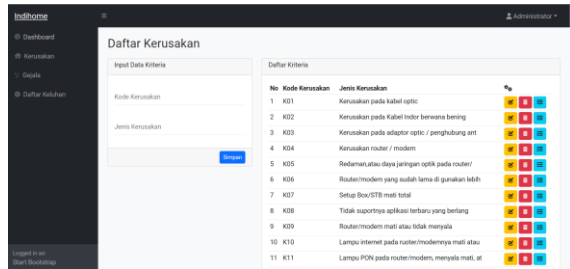


Figure 6. Interface Page for Managing Crash Data

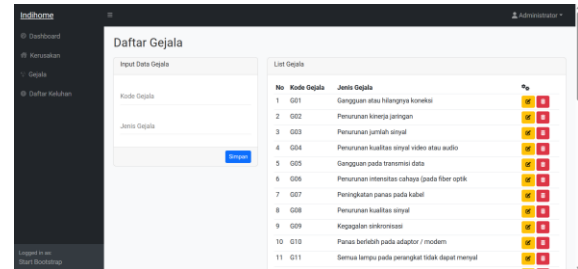


Figure 7. Manage Symptom Data Interface Page

Figure 7 presents the interface page for managing symptom data. Similar to the crash data interface, the left side features an input form used for adding or modifying symptom data. The right side lists the existing symptom data with options to change or delete entries.

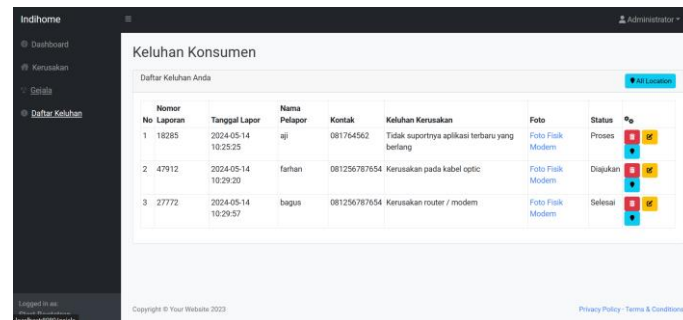


Figure 8. Interface Page Managing Customer Complaint Data

Figure 8 shows the interface page for managing customer complaints. This page displays the complaint data in a table format, where users can view customer locations, change customer statuses, and delete customer records.

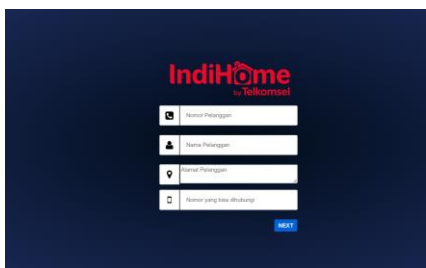


Figure 9. Filling in Customer Data



Figure 10. Customer Damage Questions



Figure 11. Result

Figure 9 depicts the interface where customers are required to fill in their details when reporting complaints related to the IndiHome network. In Figure 10, customers are prompted with questions regarding the damage they are experiencing, based on the system's damage data. The results, shown in Figure 11, provide a diagnosis of the symptoms leading to the identified damage.

3.1.4 Testing

The system testing was conducted using the black box testing method, which focuses on evaluating the functionality of the system without considering the internal code structure. The testing process is documented in Table 4, detailing various scenarios, expected outcomes, actual results, and any remarks on the system's performance.

Table 4. Testing

Description	Test Scenario	Expected Outcome	Actual Outcome	Remarks
Admin Login	Entering the wrong Username and Password	Login will Fail	Login Failed	Succeed
	Enter the correct Username and Password	Login will succeed	Login successful	Succeed
Manage Crash Data	Blank the damage form	Can't save data	Can't save data	Succeed
	Fill out all forms	Data saved successfully	Data saved successfully	Succeed
Manage Symptom Data	Blank the damage form	Can't save data	Can't save data	Succeed
	Fill out all forms	Data saved successfully	Data saved successfully	Succeed
Manage Knowledge Base Data	Blank the damage form	Can't save data	Can't save data	Succeed
	Fill out all forms	Data saved successfully	Data saved successfully	Succeed
Customer Reports a Complaint	Not filling out the form	Unable to proceed to the question stage	Unable to proceed to the question stage	Succeed
	Fill out the form	Go to the question stage	Go to the question stage	Succeed

This table demonstrates that the system's functionality meets the expected outcomes across all tested scenarios. The black box testing confirms that the system operates as intended, with successful execution of all functions in the different user scenarios tested.

3.2 Discussion

System testing is carried out to ensure its functionality is running properly. In testing the admin login feature, the first scenario involves entering the wrong username and password, where the expected result is that the login will fail, and the result obtained is by the expectations, i.e. the login fails. The second scenario involves entering the correct username and password in the hope that the login will be successful and the result is appropriate, i.e. the login is successful. For the corruption data management feature, testing was performed by blanking a form where the system is expected to be unable to save data, and the results show the system successfully prevented empty data storage. When all forms are filled out, the data is expected to be saved successfully, and the result is; accordingly, that is, the data is successfully saved. Similar tests were conducted for symptom data management features and knowledge base data, with consistent results, where the system successfully prevented empty data storage and successfully stored complete data. The last test was done on the complaint reporting feature by customers. When the reporting form is not filled out, it is expected that the system cannot proceed to the inquiry stage, and the results show that the system is functioning correctly, i.e. it cannot continue without filling out the form. Conversely, when the form is filled out, the customer is expected to enter the question stage, and the results are also in line with expectations; that is, the customer can proceed to the question stage. Overall, testing shows that all system features work as expected.

4. Related Work

The following are some references used in developing and testing this expert system. These references include literature related to methods and techniques applied in the system, similar case studies that have been successful, and technical guidance for software implementation. Using these references, the expert system can achieve optimal results based on the objectives set. Previous studies have been conducted by Hartini and colleagues in 2022. This research discusses Plasa Telkom Muara Teweh as part of PT. Telekomunikasi Indonesia provides telecommunication services, including Speedy and IndiHome internet services.

Along with the launch of IndiHome on January 1, 2015, the demand for installation of this service increased rapidly. However, this high demand also implies frequent complaints or reports of internet connection disruptions from IndiHome customers. Technicians are receiving reports of customers' inability to connect to the internet. The fault handling process involves technicians contacting the customer to ascertain the damage before going to the site. Information required by the technician, such as the status of the indicator light on the subscriber's modem, is recorded and used as a basis for repairs. However, the results of technician predictions are only sometimes accurate. Therefore, the study aims to analyze how technicians can more quickly identify the cause of internet connection interference using computer software-based expert systems. The expert system method used in this study is the Forward Chaining method. The development method uses the waterfall method, while the design method uses the structured method [12].

Continued by Muhammad Sya'i and his research team in the same year. This study discusses how each internet service provider has different characteristics, including tools, quality, and price differences. Although IndiHome has a stable network, this stability does not guarantee to avoid damage or disruption. Problems often arise in internet connections, not only during network construction but also during daily use. Interference includes a suddenly dropped connection, inability to share data, and printing problems on printers on the network. This problem is often caused by software damage and a need for network users to understand it. The impact is felt by network administrators, who have difficulty diagnosing disruptions in a practical and timely manner, especially for problems that require quick resolution. The expert system method used in this study is Forward Chaining. The results of this study show the successful implementation of an expert system to diagnose Internet connection problems in Indihome using a forward chaining approach using PHP. The system is efficient and effective in disease consultation, analysis of diagnosis results, and data management. The output is based on user needs, making this expert system a successful and reliable solution for Indihome's internet connection blackout consulting services [13].

Egar Abdi Prasetya has also conducted previous research in 2021. This study discusses Indihome services by PT Telekomunikasi Indonesia, which involve landline telephone packages, internet, and interactive television. New installation and disruption handling are the customer's right. Physical and logical disturbances are reported through the call centre managed by customer service. Obstacles arise in handling disruptions, especially the effectiveness of solutions provided by customer service. If that doesn't work, a nuisance ticket is opened for a technician visit. The main problems are: The inefficiency of reporting time, The waiting for technicians, and The need for more customer knowledge. Stacking of outage tickets affects performance and handling quality. It is necessary to increase the speed and response of services, including creating a fault identification system that customers can access directly, to increase Indihome's satisfaction and efficiency in handling disruptions. The expert system method used in this study is the Certainty Factor [14].

In addition, Fadli Fadillillah and his team also participated in the study in 2022. This study discusses Internet Connection Problems as an impact of disruption experienced at essential times, where the effect can cause financial losses due to delays in sending up, loading and downloading a file. Problems that occur on the internet include being unable to connect to the internet, slow internet connection, and inability to share files on the local network. This is a factor in decreasing performance results for any agency. Based on the results of this study, it can be concluded that the application of the Expert System for Diagnosing Internet Connection Disorders Baznas Kota Pekanbaru, which uses the Backward Chaining Method and is implemented with Pascal programming using Delphi 7, has succeeded in overcoming the problem of Internet connection interference. Scenario testing showed that the system could trace the disturbance according to the facts of the symptoms that appeared on the internet connection at BAZNAS Pekanbaru City. Using the Backward Chaining Inference engine in desktop-based applications with Delphi 7, the system can provide a solution to quickly execute internet connection interruptions based on the type of interference and symptoms identified in the field. In conclusion, the design of this system is successful because it can function well in overcoming problems related to internet connection interference in the BAZNAS environment of Pekanbaru City [15].

Finally, Pria Sukanto and his colleagues carried out research in 2023. This research discusses the development of expert systems to speed up and simplify the process of troubleshooting LAN networks, especially for users of wifi internet access. This expert system is designed to provide consultation through computer media to general users so that they can more quickly understand LAN network troubleshooting problems and find out the risk factors of damage that may occur. This expert system can provide a detailed understanding to users unfamiliar with network problems, increase efficiency in dealing with problems, and speed up troubleshooting resolution. The results showed that applying expert systems in diagnosing local area network problems can significantly speed up the process of diagnosing network damage. The system fulfils research objectives to improve efficiency and problem-solving speed. The expert system developed can be used in general situations and implemented on widely used and easily accessible Internet websites [16].

The current research differs from previous research, especially in the context and approach used. This study focuses on solving Indihome's network problems at PTTA Papua using backward chaining methods, while previous studies examined various aspects of network disruption in different locations and conditions with varied methods such as forward chaining and certainty factors. In addition, the study emphasizes customer education and additional on-site fulfillment policies to improve the efficiency and effectiveness of disruption management, a new approach that has yet to be widely discussed in previous studies.

5. Conclusion

Based on the development of an expert system for diagnosing Indihome's network connection disorders using the backward chaining method, it was concluded that this system was successfully built to improve the ability to handle network problems experienced by customers. The system aims to improve customer satisfaction, handling time efficiency, and better communication quality, which supports efforts to improve overall service quality. With the use of backward chaining methods, expert systems can identify the cause of disruption based on symptoms reported by customers, allowing technicians to take more precise and efficient steps in problem resolution. In addition, the system also provides new solutions in terms of customer education to provide more specific information when reporting network problems, as well as additional on-site fulfillment policies to improve problem handling efficiency. Thus, this expert system is expected to make a positive contribution in improving service quality and customer satisfaction within PTTA Papua.

References

- [1] Susyanto, B. (2022). Manajemen Lembaga Pendidikan Islam Dalam Menghadapi Era Digital. *Al-Madrasah: Jurnal Ilmiah Pendidikan Madrasah Ibtidaiyah*, 6(3), 692–705. <https://doi.org/10.35931/AM.V6I3.1072>
- [2] Adha, S. (2022). Faktor revolusi perilaku konsumen era digital: sebuah tinjauan literatur. *Jipis*, 31(2), 134–148.
- [3] Wiranti, N. E., & Frinaldi, A. (2023). Meningkatkan Efisiensi Pelayanan Publik dengan Teknologi di Era Digital. *JIM: Jurnal Ilmiah Mahasiswa Pendidikan Sejarah*, 8(2), 748–754. <https://doi.org/10.24815/jimps.v8i2.24833>
- [4] Kiswanto, R. H., Bakti, S., & Thamrin, R. M. H. (2021). Rancang Bangun Sistem Pakar Diagnosa Penyakit Kucing Menggunakan Metode Backward Chaining. *Jurnal Eksplora Informatika*, 11(1), 67–76. <https://doi.org/10.30864/EKSPLORA.V11I1.610>
- [5] Stefani, M. R. (2022). Sistem Pakar Diagnosa Penyakit Pada Ikan Koi Menggunakan Metode Backward Chaining. *Jurnal Riset Rumpun Ilmu Hewani*, 1(2), 16–30. <https://doi.org/10.55606/JURRIH.V1I2.526>
- [6] Gago, G. F., & Pernando, Y. (2023). Sistem Pakar Untuk Menentukan Tingkat Bahaya Penyakit Parestesia Pada Suatu Individu Dengan Menggunakan Metode Backward Chaining. *Jurnal Computer Multimedia Engineering*, 1(1), 14–21. Available at <https://komputer.iam-indonesia.org/index.php/jcome/article/view/3>
- [7] Amalia, C. R. P., & Mahyuddin. (2023). Perancangan Sistem Pakar untuk Mendiagnosa Tingkat Stress Belajar pada Siswa SMA dengan Menggunakan Metode Forward Chaining. *Design Journal*, 1(1), 38–54. <https://doi.org/10.58477/dj.v1i1.27>
- [8] Amanda, O., Nurlifa, A., Amaluddin, F., & Hidayah, N. (2023). Sistem Pakar Untuk Diagnosa Penyakit Gigi Dan Mulut Menggunakan Metode Forward Chaining Berbasis Web. *Curtina*, 4(1), 12–22. <https://doi.org/10.55719/CURTINA.V4I1.823>

-
- [9] Lestari, D. I., et al. (2023). Website Sistem Pakar Untuk Diagnosa Penyakit Gigi Pada UPT Puskesmas Babat Toman. *Jurnal Ilmiah Bin STMIK Bina Nusantara Jaya Lubuklinggau*, 5(2), 152–159. <https://doi.org/10.52303/JB.V5I2.120>
- [10] Fuad, E., Wenando, F. A., & Vannada, M. R. (2022). Sistem Pakar Diagnosa Penyakit Demam Berdarah Dengue Secara Dini Menggunakan Metode Certainty Factor. *JuSiTik: Jurnal Sistem dan Teknologi Informasi Komunikasi*, 6(1), 1–12. <https://doi.org/10.32524/JUSITIK.V6I1.785>
- [11] NurJumala, A., Prasetyo, N. A., & Utomo, H. W. (2022). Sistem Pakar Diagnosis Penyakit Rhinitis Menggunakan Metode Forward Chaining Berbasis Web. *JURIKOM: Jurnal Riset Komputer*, 9(1), 69–78. <https://doi.org/10.30865/JURIKOM.V9I1.3815>
- [12] Hartini, Teruna, J. C., & Swastina, L. (2022). Identifikasi Gangguan Koneksi Jaringan Internet Pada Indihome Plasa Telkom Muara Teweh Berbasis Sistem Pakar. *Computer Based Information System Journal*, 10(1), 5–11. <https://doi.org/10.33884/CBIS.V10I1.5456>
- [13] Sya'i, M., Gunawan, I., Irawan, Poningsih, & Dewi, R. (2022). Sistem Pakar untuk Mendeteksi Kerusakan Jaringan Internet pada Indihome di Pematangsiantar. *Jurnal Ilmu Komputer dan Informasi*, 2(1), 37–46. <https://doi.org/10.54082/JIKI.17>
- [14] Prasetya, E. A. (2021). Identifikasi Gangguan Jaringan Dengan Metode Certainty Factor Di PT.Telkom Malang Guna Peningkatan Pelayanan Customer. *J-INTECH: Jurnal Informasi Teknologi*, 9(01), 1–5. <https://doi.org/10.32664/J-INTECH.V9I01.547>
- [15] Fadilillah, F., Amir, F., Riyanto, D. Prayama, & Oriyasmi, F. (2022). Diagnosa Permasalahan Koneksi Internet Dengan Metode Backward Chaining. *Proceedings of Applied Business Engineering Conference*.
- [16] Sukamto, P., Agustian, M. C., & Abdurahman, U. T. (2023). Aplikasi Sistem Pakar Diagnosa Troubleshooting Jaringan Local Area Network Menggunakan Metode Backward Chaining. *INFOTECH Journal of Information Technology*, 4(1), 128–136. <https://doi.org/10.37373/INFOTECH.V4I1.397>