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IMPLEMENTATION OF FORWARD CHAINING IN EXPERT SYSTEM FOR COMPUTER TROUBLESHOOTING

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Abstract: CV. Ria Kencana Ungu (RKU), as a research partner in the field of computer service, needs to improve the quality of customer service and efficiency in the process of troubleshooting computer damage. To meet these needs, an expert system based on the forward chaining method was developed that is able to diagnose damage automatically. This system was developed using the waterfall method, with systematic stages from analysis to implementation. The implementation results show that the system can identify the type of damage with an accuracy rate of 89% based on validation tests on 100 real troubleshooting cases. The evaluation metric uses a comparison between the results of the system diagnosis and the results of the technician's analysis. Although the system is able to increase service efficiency by up to 40% compared to conventional methods, several obstacles were found, such as the limited initial knowledge base that impacts the accuracy of the diagnosis and the difficulty of users in understanding the system interface. Therefore, further development is needed to expand the knowledge base and improve the user experience. This study aims to develop a forward chaining-based expert system to improve efficiency, accuracy, and speed of problem solving at CV. Ria Kencana Ungu (RKU) and to increase customer satisfaction through more responsive and precise services..

Keywords: expert system; computer troubleshooting; forward chaining method

Abstrak: CV. Ria Kencana Ungu (RKU), sebagai mitra penelitian di bidang layanan servis komputer, membutuhkan peningkatan kualitas layanan pelanggan dan efisiensi dalam proses troubleshooting kerusakan komputer. Untuk memenuhi kebutuhan tersebut, dikembangkan sistem pakar berbasis metode forward chaining yang mampu mendiagnosis kerusakan secara otomatis. Sistem ini dikembangkan menggunakan metode waterfall, dengan tahapan yang sistematis dari analisis hingga implementasi. Hasil implementasi menunjukkan bahwa sistem dapat mengidentifikasi jenis kerusakan dengan tingkat akurasi sebesar 89% berdasarkan uji validasi terhadap 100 kasus troubleshooting nyata. Metrik evaluasi menggunakan perbandingan antara hasil diagnosis sistem dan hasil analisis teknisi. Meskipun sistem mampu meningkatkan efisiensi layanan hingga 40% dibandingkan metode konvensional, beberapa kendala ditemukan, seperti keterbatasan basis pengetahuan awal yang berdampak pada akurasi diagnosis dan kesulitan pengguna dalam memahami antarmuka sistem. Oleh karena itu, pengembangan lebih lanjut diperlukan untuk memperluas basis pengetahuan dan meningkatkan pengalaman pengguna. Penelitian ini bertujuan mengembangkan sistem pakar berbasis forward chaining untuk meningkatkan efisiensi, akurasi, dan kecepatan troubleshooting di CV. Ria Kencana Ungu (RKU) serta meningkatkan kepuasan pelanggan melalui layanan yang lebih responsif dan presisi.

Kata kunci: sistem pakar; troubleshooting komputer; metode forward chaining

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INTRODUCTION

In the era of business dominated by information technology, the role of computers in supporting company operations has become critically important. However, as the complexity of this technology increases, companies often encounter various malfunctions and technical issues with their computers, which can hinder productivity and operational performance. Therefore, effective solutions are required to address these problems, ensuring that business operations run smoothly and optimally.

CV. Ria Kencana Ungu (RKU), as a research partner engaged in computer service and sales, has a pressing need to enhance customer service quality and expedite the troubleshooting process for computer malfunctions. By implementing the forward chaining method in the development of a troubleshooting expert system, it is expected that RKU will be able to provide faster, more accurate, and more efficient services to customers, significantly improving customer satisfaction levels.

According to articles [1] and [2], the forward chaining method is one of the approaches in artificial intelligence used to develop expert systems. Expert systems that utilize this method have the capability to analyze symptoms or initial information and automatically seek appropriate solutions or diagnoses. The application of the forward chaining method in the context of troubleshooting computer malfunctions has the potential to enhance efficiency in identifying and resolving technical issues.

This research references previous studies on expert systems for gynecological disease detection [3] and [4], which also employed the forward chaining method, as both studies utilize the same approach. This provides insights into how the method can be applied in an application context. The advantage of this research compared to previous studies lies in the relevance of the expert system for troubleshooting computer malfunctions, aligning with the needs of the technology industry and computer users in general. Furthermore, the products and applications developed from this research hold significant commercialization potential.

This research aims to enhance efficiency and accuracy in the troubleshooting process of computer malfunctions at the RKU computer service center. By applying this approach, it is anticipated that the developed expert system will systematically analyze symptoms of malfunctions, identify potential causes, and present appropriate solutions. Consequently, this system will provide optimal support for technicians at RKU in addressing various computer repair challenges.

The contribution of this research is the innovation achieved through the implementation of the forward chaining method in the development of an expert system for troubleshooting computer malfunctions. This system offers solutions for CV Ria Kencana Ungu (RKU), which operates in the service sector, by introducing the latest technology aimed at enhancing efficiency in computer service and sales.

METHOD

Research Flow [5]

The research flow diagram explaining the stages in the ongoing research is presented in Image 1 as a reference in the development and analysis process.

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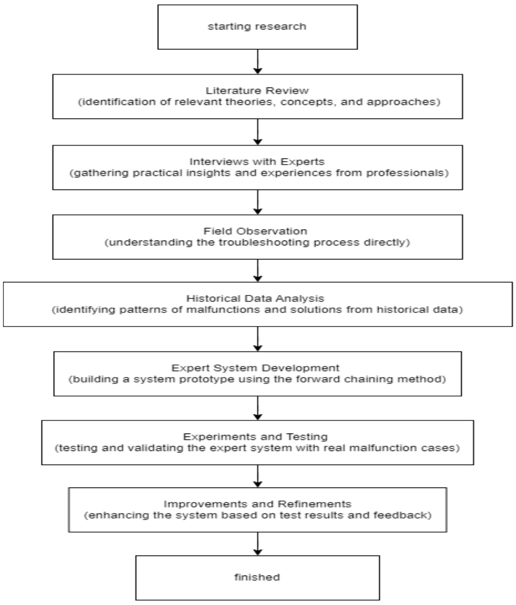

Image 1. Research Flow

Explanation of Image 1 Research flowchart, showing the systematic stages in developing a computer damage troubleshooting expert system based on forward chaining. The process begins with literature studies, expert interviews, and field observations to understand troubleshooting methods. Furthermore, historical data analysis is carried out to identify damage patterns and solutions that have been applied. Based on these data, a system prototype is developed and tested using real cases. The test results are then analyzed for system refinement before the research is declared complete. This approach ensures that the expert system developed is accurate, effective, and data-driven.

System Development Methodology

The waterfall method is a linear and sequential approach to software development [6], [7]. In this method, each development phase must be fully completed before proceeding to the next phase, thereby creating a structured workflow. The following are the main stages involved in the waterfall method, namely analysis, design, implementation, testing, deployment, and maintainance.

Data Collection Methods

This study uses several data collection methods to obtain accurate and relevant information. 1) Literature study method [8]: Collecting data from books, journals, and scientific publications to identify theories and concepts related to forward chaining and expert systems., 2) Interview [9]: Involving information technology experts through face-to-face meetings, telephone calls, or video calls to gain in-depth insights., 3) Field observation [10]: Directly observing the problem-solving process in a computer service center or IT department to understand the application of methods in the real world.

Forward Chaining Method

The forward chaining method [11], [12] is one of the inference techniques in rule-based systems, particularly in artificial intelligence and expert systems. Forward chaining is a method used in the inference engine to initiate the reasoning process or data tracking from existing facts, with the aim of reaching a conclusion [13]. If the input facts match the IF part, then the corresponding rule is executed. The process of rule application can be seen in Image 2.

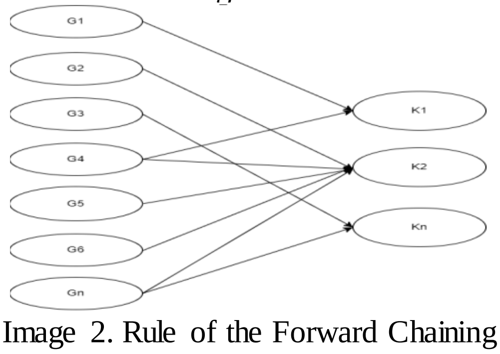

Image 2. Rule of the Forward Chaining Method

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$$G1 + G2 + G3 + ... + Gn = K1/K2/Kn \quad (1)$$

Description:
G = Symptoms of computer malfunctions based on facts and data.
K = Diagnosis results.

RESULT AND DISCUSSION

Implementation of Results

After analyzing and designing, the next step is to implement the results in the application that has been developed. The data on malfunctions and symptoms obtained from information collection through observation, interviews, and literature study can be seen in Table 1 and Table 2. Additionally, the determination of rules using the forward chaining method that predicts computer malfunctions is displayed in Table 3.

Table 1. Data on Computer Malfunctions

Malfunction Code	Description of Malfunction
K01	Main-board/Motherboard
K02	Processor
K03	Chipset/VGA
K04	Hard disk
K05	RAM (memory)
K06	Keyboard/Touchpad
K07	Malfunction in LCD
K08	Laptop battery
K09	Laptop charger
K10	Windows Operating System (OS)

In the application developed by the researcher, there are 10 malfunction data entries that have been input. This data can still increase, decrease, or change according to the latest information from experts. These malfunctions also have indications or symptoms that may point to hardware issues.

Table 2 above presents the symptom codes along with explanations of the names of each symptom associated with those codes, comprising a total of 42 symptoms.

Table 3 above explains the rules regarding the relationship between malfunction codes and symptoms experienced by the user.

Table 2. Data on computer malfunction symptoms.

Code	Symptom Description
G01	The power on-off button is not functioning
G02	All LED indicators are off
G03	The display sometimes turns off and on
G04	The message "warning CMOS battery is low, press F1 to resume" appears
G05	The laptop suddenly restarts or shuts down by itself
G06	The laptop hangs, errors, or does not display anything
G07	The hard disk is not detected in the laptop BIOS
G08	Blue screen appears
G09	The laptop is not charging
G10	The adapter light blinks when plugged into the laptop
G11	The machine powers on briefly and then shuts down
G12	The laptop is completely dead
G13	Booting fails when the laptop is turned on

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Code	Symptom Description
G14	The screen does not display anything
G15	Irregular colored lines appear on the screen
G16	No power is incoming
G17	Data or system loading is slow
G18	Emits unusual sounds
G19	Unable to access Windows
G20	The message "unknown disk boot error" appears
G21	The message "retry boot disk" appears
G22	Unable to install the operating system
G23	Beep sound during the boot process
G24	The keyboard is not functioning
G25	The touchpad or mouse is not functioning
G26	Certain keys on the keyboard are not working
G27	Errors when typing letters or numbers appear incorrectly
G28	It makes a "tut" sound when turned on, and the keyboard types by itself.
G29	The function (FN) key is not working
G30	The display appears dim
G31	The LCD condition is dark
G32	Horizontal or vertical lines appear on the LCD screen
G33	The display shows only half of the image
G34	The LED battery indicator on the charger does not light up
G35	The battery indicator shows a cross
G36	The battery is not charging
G37	Unable to recharge the laptop battery
G38	The laptop that is charging while powered on then shuts down
G39	Virus attack
G40	Errors or failures in updating the Windows operating system
G41	RAM not detected or incorrect amount
G42	Repeated "beep" sound from the computer

Table 3. Rule Determination Table Using the Forward Chaining Method

No	Rule
1	IF G02, G03, G04, G05, G06, G07, G08, G42, G09, G13 THEN K01
2	IF G05, G11, G12, G13 THEN K02
3	IF G08, G12, G14, G15, G16 THEN K03
4	IF G08, G17, G18, G19, G20, G21, G22 THEN K04
5	IF G08, G13, G41, G22 THEN K05
6	IF G23, G24, G25, G26, G27, G28 THEN K06
7	IF G29, G30, G31, G32 THEN K07
8	IF G33, G34, G35 THEN K08
9	IF G33, G36, G37 THEN K09
10	IF G17, G21, G38, G40 THEN K10

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Testing

Testing is conducted using the black box method, which focuses on the functionality of the developed application interface. The testing was performed on the specified items, and the results can be seen in Table 4.

Table 4. Application Testing

No	Item Name	Information	Results
1	Login	Login is successful if the data is correct, and fails if the data is incorrect.	In accordance with.
2	Profile	Profiles are used to enter data, which will be successfully viewed if the data is entered correctly.	In accordance with
3	Symptom Data	The symptom data input process will be successfully displayed if the inputted data is correct, and the process will fail if the inputted data is incorrect.	In accordance with.
4	Malfunction Data	Malfunction data input will be displayed successfully if the input data is correct, and will fail if the data entered is incorrect.	In accordance with.
5	Rules for Predicting Malfunctions	Rules for determining the type of damage based on symptoms. The results of processing this rule can be used in the damage inspection menu.	In accordance with.
6	Trouble-shooting	The troubleshooting section is used to perform initial checks for computer damage.	In accordance with.
7	Settings	The settings menu is used to reset the password as needed.	In accordance with.
8	Logout	The exit menu is used to exit the application	In accordance with..

After testing was conducted, the results obtained indicate that the application functions as intended, with no errors found during the testing process. Therefore, the conclusion of this testing is that the developed application has effectively fulfilled its function.

Application Testing

Predicting computer damage. For example: select G08, G17, G18, G19, G20, G21, G22 (symptoms or issues encountered), and K04 (indicating the diagnosis result based on the symptoms). With the rule (IF G08, G17, G18, G19, G20, G21, G22 THEN K04). The interface that displays the malfunction prediction results can be seen in Image 3.

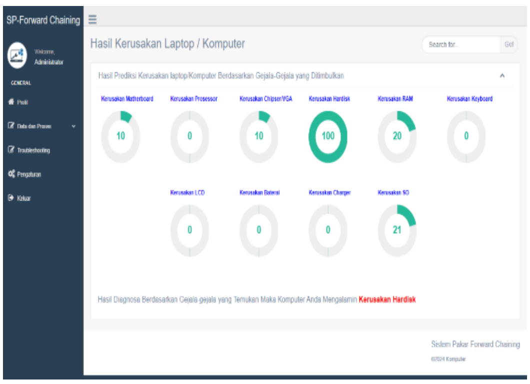

Image 3. Results of the Check

CONCLUSION

The development of a forward chaining-based expert system at CV. Ria Kencana Ungu (RKU) improves the efficiency and accuracy of computer troubleshooting. This system achieves 89% accuracy based on validation tests on 100 cases, and increases service efficiency by up to 40% compared to conventional methods. However, the limitations of the initial knowledge base and the lack of ease of interface are still obstacles. Further development is needed to expand the knowledge base and improve usability. Thus, this system is expected to be able to improve the quality of technical services, operational efficiency, and customer satisfaction..

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