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Identification Computer Hardware Malfunction using *Cartainty Factor*

Afriza Ali Zighovit[1], Rifki Adhitama[2*], Amalia Beladinna Arifa[3]

[1,3]*Department of Informatics, Institut Teknologi Telkom Purwokerto, Indonesia*
[2]*Department of Software Engineering, Institut Teknologi Telkom Purwokerto, Indonesia*
[*]Corresponding Author: rifki@ittelkom-pwt.ac.id

Abstract

A computer is an electronic device designed to receive input, process it, store processing instructions, and deliver output as information. Hardware refers to the physical components of a computer that are tangible and visible. Due to inadequate knowledge in troubleshooting computer malfunctions, novice users often face challenges in identifying the source of hardware issues. Consequently, not all users are equipped to repair hardware problems, which may lead to unnecessary repair costs for issues that could potentially be resolved independently. Thus, there is a necessity for a system capable of diagnosing computer hardware malfunctions, functioning as an expert system to provide practical consultation and information. This expert system is developed using PHP and Laragon. The dataset utilized in this research comprises 44 symptoms. The system design follows the Waterfall methodology for system analysis and employs the Certainty Factor method for diagnosing types of malfunctions and accuracy is evaluated using a Confusion Matrix. The system for identifying computer hardware malfunctions achieved an accuracy rate of 75%.

Keywords: Certainty Factors, Computer Hardware Damage, Confusion Matrix, Expert Systems, Waterfall

Abstrak

Komputer adalah perangkat elektronik yang dirancang untuk menerima input, memprosesnya, menyimpan instruksi pemrosesan, dan memberikan output dalam bentuk informasi. Hardware mengacu pada komponen fisik komputer yang berwujud dan terlihat. Karena kurangnya pengetahuan yang memadai dalam memecahkan masalah kerusakan komputer, pengguna pemula sering menghadapi kesulitan dalam mengidentifikasi sumber masalah hardware. Akibatnya, tidak semua pengguna mampu memperbaiki masalah hardware, yang dapat menyebabkan biaya perbaikan yang tidak perlu untuk masalah yang sebenarnya bisa diselesaikan secara mandiri. Oleh karena itu, ada kebutuhan akan sistem yang mampu mendiagnosis kerusakan hardware komputer, yang berfungsi sebagai sistem pakar untuk memberikan konsultasi praktis dan informasi. Sistem pakar ini dikembangkan menggunakan PHP dan Laragon. Dataset yang digunakan dalam penelitian ini terdiri dari 44 gejala. Desain sistem mengikuti metodologi Waterfall untuk analisis sistem dan menggunakan metode Certainty Factor untuk mendiagnosis jenis kerusakan dan akurasi dievaluasi menggunakan Confusion Matrix. Sistem untuk mengidentifikasi kerusakan hardware komputer mencapai tingkat akurasi sebesar 75%.

Kata Kunci: Certainty Factor, Confusion Matrix, Kerusakan Hardware Komputer, Sistem Pakar, Waterfall

I. INTRODUCTION

A computer is an electronic device proficient in receiving input, processing it, storing processing instructions, and delivering output as information [1]. Given the computer's ability to manage inputs and outputs, it necessitates additional components that enable optimal functionality. One such critical component is hardware, which constitutes the tangible physical elements of a computer.

Owing to a deficiency in adequate knowledge for troubleshooting computer malfunctions, novice users frequently encounter difficulties in pinpointing the source of the issue. Consequently, not all users possess the

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capability to rectify hardware problems, often resulting in unnecessary expenditure on repairs that may be relatively straightforward and could be resolved independently [2].

Artificial Intelligence (AI) represents a discipline within computer science that empowers machines to perform tasks requiring human-like decision-making. AI is incorporated into computers to facilitate decision-making processes akin to human cognition [3]. An expert system is a computer application that encapsulates the knowledge of a human expert [4]. The primary objective of an expert system is to replicate the role of an expert in addressing problems necessitating specialized knowledge.

The Certainty Factor (CF) methodology assigns a clinical parameter value to represent the degree of confidence. This method quantifies the certainty associated with a particular fact or rule [5]. A notable advantage of the Certainty Factor method is its appropriateness for discerning the certainty or uncertainty in identifying issues. This method processes only two data points concurrently, thereby maintaining data accuracy [6].

Building on this premise and previous research that investigated computer hardware malfunctions using the forward chaining method, it has been recommended to employ an alternative inference method to achieve higher diagnostic accuracy than the previous model. This study utilizes the Certainty Factor method. Furthermore, there exists a necessity for a system capable of identifying computer hardware failures to assist users and technicians in obtaining relevant information. The waterfall model was selected for system development due to its sequential phases, which align with the research requirements. Hence, there is a need for research on the implementation of the Certainty Factor method for diagnosing computer hardware malfunctions via a web-based system.

II. LITERATURE REVIEW

This research involves an examination of previous studies that are relevant or similar to the implementation of the Certainty Factor method on a website for diagnosing computer hardware failures. Some of these studies include:

Rismayadi conducted a study titled “Design of an Expert System Application for Diagnosing Computer Hardware Damage Using the Forward Chaining Method” in 2016, which utilized the Forward Chaining method and employed the waterfall model for system development. The findings from this research indicated that the system could be used as a tool to help identify the causes of computer hardware failures [1]. In 2017, Jiwono et al. conducted a study titled “Implementation of the Naïve Bayes Method on a Web-Based Expert System Application for Diagnosing Computer Hardware Failures”. This research aimed to evaluate the performance of the Naïve Bayes method in an expert system designed to assist users. The findings indicated that the Naïve Bayes method was successfully implemented in the expert system for diagnosing computer hardware failures, achieving an accuracy rate of 100% based on 18 tests [7]. Arifini et al. conducted a study on the “Application of the Certainty Factor Method for an Expert System to Diagnose Pests and Diseases in Tobacco Plants” in 2017. This research aimed to assist farmers in combating pests and diseases affecting tobacco plants. The study achieved an accuracy rate of 99.9%, with the accuracy of the Certainty Factor method being influenced by the selection of symptom data. The Certainty Factor method proved highly suitable for diagnosing pests and diseases in tobacco plants [8].

In this research, several theoretical foundations are employed, which are explained below:

A. *Hardware*

Hardware refers to the physical components of a computer that are visible and tangible. These components are essential for optimizing a computer’s performance. Various types of hardware are necessary for a computer, including the motherboard, power supply, processor, RAM, hard drive, CD drive, mouse, keyboard, and VGA [9].

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B. *Computer*

A computer is an electronic device capable of receiving input according to given instructions, processing these instructions, and providing output in the form of information. Additionally, a computer can store programs and data processing results and operate automatically [10].

C. *Certainty Factor*

The Certainty Factor (CF) was proposed by Shortliffe and Buchanan in 1975 to accommodate the uncertainty in expert reasoning. The Certainty Factor is used to represent an expert's confidence level regarding a particular problem [11].

D. *Website*

A website is an information source that can include text, images, videos, audio, and animations. Essentially, a website comprises a vast collection of data and documents hosted on a server computer [12].

E. *PHP*

PHP (Hypertext Preprocessor) is an open-source programming language suitable for creating websites and can be embedded in scripts [13].

F. *Laragon*

Laragon is a free software package that includes various operating systems used as a localhost or standalone server. It offers numerous services and features, including Apache, PHP server, PHPMyAdmin, MySQL, and Laravel [13].

G. *Confusion Matrix*

A Confusion Matrix is a method used to calculate accuracy in data mining concepts. Accuracy in classification refers to the percentage of correctly classified data records after testing the classification results [14].

III. RESEARCH METHOD

This research uses several research stages which can be seen in Fig. 1.

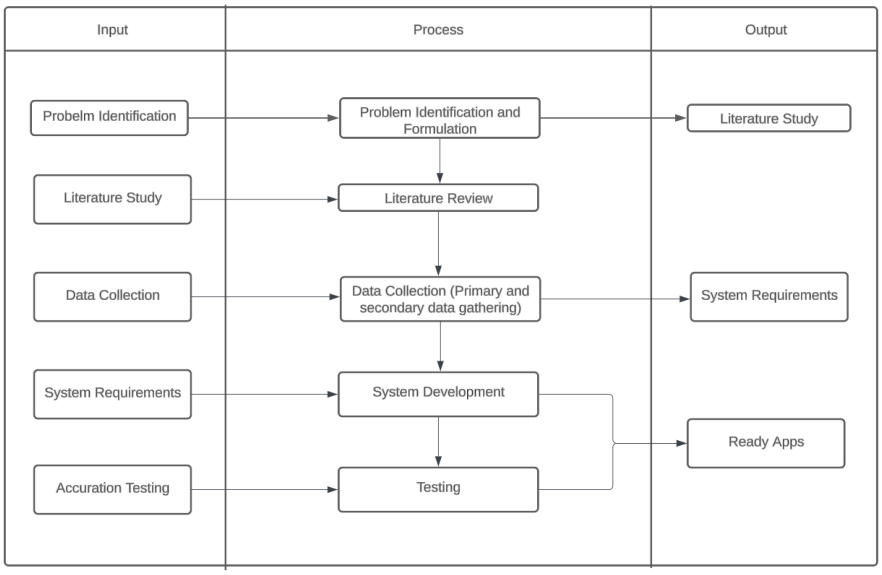

Fig. 1. Research process

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A. *Identification and Formulation of the Problem*

Researchers must determine the field, topic, and specific problem to be addressed, as well as propose the methods to be used in the research. At this stage, the focus is on studying and identifying issues related to computer hardware damage.

B. *Literature Review*

Researchers gather data related to the topic of computer hardware damage. The method employed in this research is the certainty factor method. This literature review aims to strengthen the research problem and provide a foundation for subsequent development.

C. *Data Collection*

Data collection involves gathering information on the identification of computer hardware damage. This research utilizes both literature review and interviews with experts to collect data.

D. *System Development*

In this stage, the researcher conducts a system requirements analysis to determine what is needed to create the system. Following the analysis, the system is developed, maintained, upgraded, and evaluated using the waterfall method.

E. *Accuracy Testing*

The accuracy testing stage involves evaluating the system to determine its accuracy level. The method used for this evaluation is the confusion matrix. This testing is conducted using several test data sets, from which the total number of correct and incorrect data points are used to calculate the accuracy level.

IV. RESULTS AND DISCUSSION

A. *Knowledge Base Design*

Before developing this expert system application, it is essential to establish a knowledge base and create rules to ensure the inference process operates effectively. There are 12 types of hardware damage, each with its own code. The purpose of this initialization is to facilitate the creation of a rule-based knowledge base. Additionally, there are 44 symptoms associated with these types of damage, each with its own code. The goal of this initialization is to simplify the development of the rule-based knowledge base.

The results of the knowledge base and rule creation can then be transformed into a rule table, which presents a series of rules that can be used to identify computer hardware damage. The rule creation utilizes the Certainty Factor method, starting with the experienced symptoms, leading to the results as shown in Table I.

Table I
Rule Based Table

No	Rules
1	IF K001 AND K002 AND K003 AND K004 THEN H001
2	IF K005 AND K006 AND K007 THEN H002
3	IF K008 AND K009 AND K010 THEN H003
4	IF K011 AND K012 AND K013 AND K014 THEN H004
5	IF K015 THEN H005
6	IF K016 AND K017 THEN H006
7	IF K018 AND K019 AND K020 AND K021 THEN H007
8	IF K022 AND K023 AND K024 AND K025 AND K026 AND K027 AND K028 AND K029 AND K030 THEN H008
9	IF K031 AND K032 THEN H009
10	IF K033 AND K034 AND K035 AND K036 THEN H010
11	IF K037 AND K038 AND K039 THEN H011
12	IF K040 AND K041 AND K042 AND K043 AND K044 THEN H012

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The rule table is derived from the dataset used in this research. The dataset groups symptoms associated with hardware damage. For example, the first rule, IF K001 AND K002 AND K003 AND K004 THEN H001, identifies symptoms of mouse damage.

B. *System Development and Design*

The system development and design process involve several stages, including the design of use case diagrams, activity diagrams, sequence diagrams, and system interface or mock-up design. The use case diagram includes two actors: regular users and admin. Users can view the home menu and conduct consultations, which provide information on symptoms and types of computer hardware using the Certainty Factor method. Admins can access all system menus and manage the system data to maintain the system.

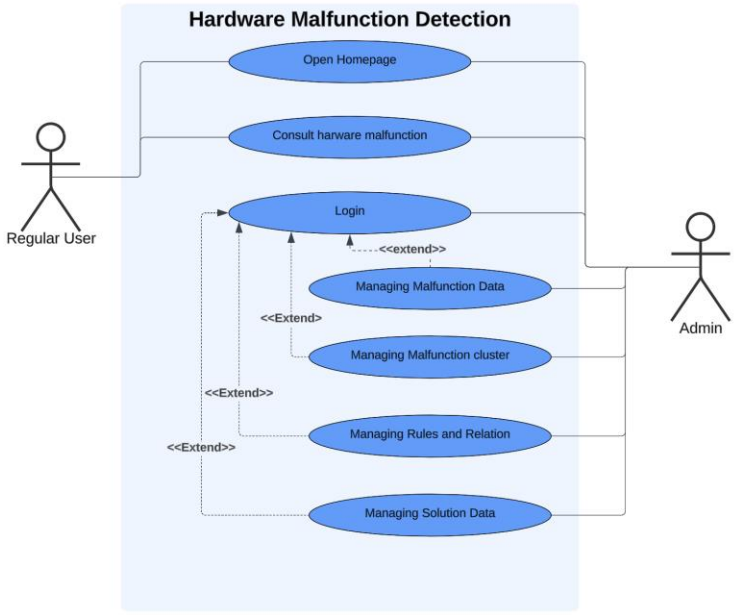

Fig. 2. Use Case Diagram

C. *System Implementation*

The system implementation stage involves presenting the results of the program implementation using PHP and Visual Studio Code. This stage demonstrates the implementation of the certainty factor-based computer hardware damage system on the web.

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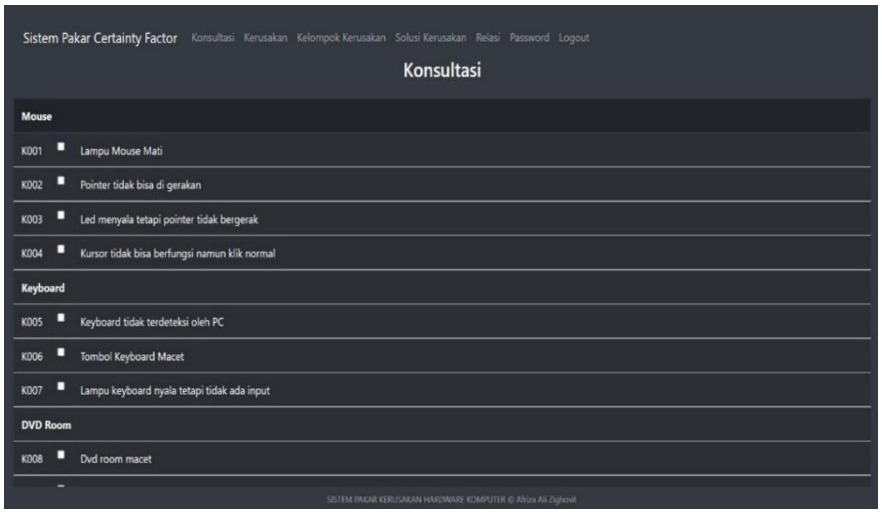

Fig. 3. Consultaion Page

Fig. 3. shows the user page, which includes a consultation interface, and the navigation menu features an admin login option. Fig. 4. illustrates the consultation page, displaying the results of the certainty factor calculations based on the symptoms selected by the user. The user can then click "process" to view the consultation results.

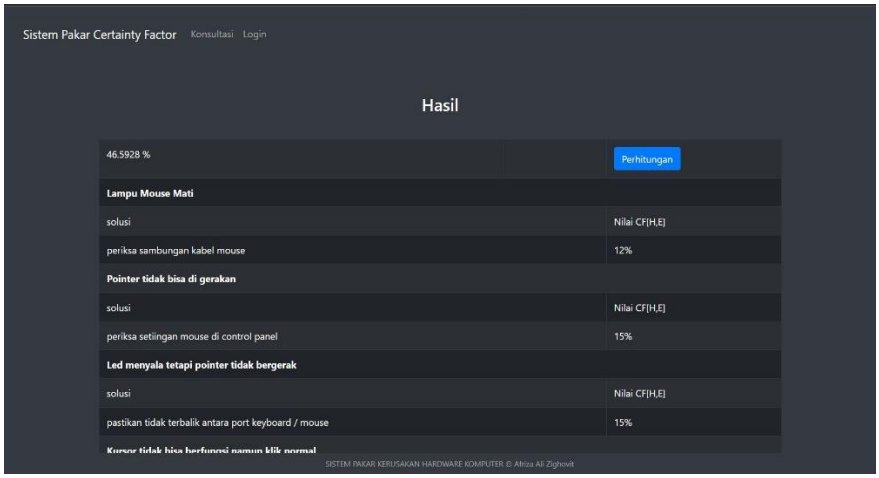

Fig. 4. Result Page

D. *System Testing*

Following implementation, the next stage is system testing, aimed at identifying errors and shortcomings within the system. This testing is conducted using white-box and black-box testing methods. The focus of this stage is to verify whether the system's functionalities meet the expected requirements.

E. *Accuracy Testing*

The accuracy testing stage evaluates whether the developed system can accurately identify computer hardware damage. This testing uses the confusion matrix method. Among the 12 rules created, nine rules were consistent with expert opinions, while three were less accurate. Based on the confusion matrix calculations, the expert system demonstrates a good capability to identify computer hardware damage, achieving an accuracy rate of 75%.

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V. CONCLUSION

1. Implementation of Certainty Factor Method for Web-Based Computer Hardware Damage: The system proved to be effective, as evidenced by accuracy tests with experts. Out of the 12 hardware damage rules, 9 were accurate, and 3 were less accurate, resulting in an overall accuracy rate of 75%.
2. System Development and Implementation: The system, developed using the waterfall method, included stages of requirements analysis, system design, coding, testing, and maintenance. The successful design and implementation of the system demonstrate its effectiveness.

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