Journal of Computer Science and Information Technology
https://jcsitech-upiyptk.org/ojs
20 2 2 Volumes 8 Issue 3 Matter: 60-65 e-ISSN: 2502-1486

Case Based Reasoning Method for Diagnosing Air Conditioner Damage

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Abstract

Technological advances greatly impact the continuity and comfort of human life, for example the use of air conditioners (AC). AC is a room conditioning tool that is able to condition the air in the room and provide a comfortable effect on the body. Air conditioning (AC) is a system or machine designed to stabilize air temperature and humidity in a certain area by circulating refrigerant gas through the refrigeration process. The research framework created in this research methodology aims to get the results as expected and easy to solve problems and easy to understand. In collecting data, researchers obtain data from various sources such as journals, books and other references to the object of research. This research was carried out by applying the interview method directly to Cv. Ihfha belongs to Mr. Jean Hilman. With an Expert System using the Case Based Reasoning (CBR) method, it can help employees work more elegantly and efficiently because all data collection about damage to the air conditioner is already in the system, so the owner can find out what is the damage to the air conditioner and can be done faster. the owner can already find out what damage is to the AC and can be done more quickly.

Keywords: Air Conditioner , Expert System, Case Based Reasoning (CBR), Refrigeration Process, Efficiency

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1. Introduction

Technological advances greatly impact the continuity and comfort of human life, for example the use of *Air Conditioners* (AC). AC is a room conditioning tool that is able to condition the air in the room and provide a comfortable effect on the body [1]. The air conditioning system (*air conditioner*) is the process of regulating temperature, humidity, and air distribution in an effort to achieve comfortable conditions that are certainly needed by every occupant who is in it [2].

Currently the application of computer science in the field of electronics is growing and computer science can help owners of electronic objects to predict damage from the causes that occur and how to handle solutions. One of the computer sciences that is currently developing into various fields is expert systems. Expert systems can be applied in the field of electronics in terms of diagnosing damage to *Air Conditioners* (AC).

An expert system is a computer-based application that is used to solve problems as done by experts. The expert referred to here is a person who has special expertise who can solve problems that cannot be solved by ordinary people [3].

Expert System (*Expert System*) is a field of computer science that utilizes computers so that they can behave intelligently like humans. Expert systems try to adopt human knowledge into computers , so that computers can solve problems as experts usually do [4]. An expert expert not only has the ability to diagnose a disease. One can explain and understand patterns related to the problem cases, and can be rearranged the knowledge obtained to overcome problems and suitability of expertise [5].

The expert system consists of two parts that must be owned, namely the knowledge base and the inference engine. Knowledge base is a database that stores certain knowledge information and rules about certain subjects,

Received: 15-05-2022 | Revision: 24-06-2022 | Published: 31-07-2022 | doi: 10.35134/jcsitech.v8i3.36

while the inference engine is part of an expert system that tries to use the information provided to find the appropriate object [6].

Expert systems began to be developed in 1960 and 1970 and were only implemented in 1980. The general form of an expert system is a computer program that is created based on a set of rules or rules that analyze a specific problem and analyzes the problem mathematically. Knowledge stored on a computer is known as a knowledge base. In Expert Systems there are two types of knowledge, namely facts and procedures [7]. With an expert system, of course, people are able to solve problems, where these problems can only be solved and worked on by experts [8]. It can be said that the Expert System helps or becomes an assistant to an expert in carrying out his work [9].

Air *conditioning* (AC) is a system or machine designed to stabilize air temperature and humidity in a certain area by circulating refrigerant gas through the refrigeration process. Mr. Jean Hilman's AC Service is an AC repair service that was established in 2016. The address is Jl. mt. Ledang Kelurahan No.25, Mt. Pangilun, Padang Utara District, currently the process of checking for AC damage is done manually and has not yet implemented an information system, so there are still many defects that Mr. Jean Hilman has not known about. Basically damage to the *Air Conditioner* (AC) can be caused by several unstable factors, also the age factor , AC components that are out of date and even worn out. With a relatively frequent frequency, and poor maintenance can cause the AC to be damaged. Both minor damage, and severe damage that causes the air conditioner to not work properly.

The system is a group of interacting or interrelated entities that form a unit to achieve certain goals. Systems can be classified into discrete systems and continuous systems. The system is a set of elements that are interrelated and influence each other in carrying out the process of activities to achieve one goal [10].

Information can be defined as the result of data processing in a form that is more useful and more meaningful to the recipient which describes a real event that is used for decision making. Based on the definition of information above , the writer can conclude that information is raw data that has been processed in such a way as to produce something meaningful for its users in making a decision [11].

An information system is a collection of sub-systems, both physical and non-physical, that are interconnected with each other and work together harmoniously to achieve a goal, namely to process data into useful information. An information system is a series of two or more interconnected components that interact to achieve a goal. Most systems consist of smaller subsystems that support larger systems [12].

Case Based Reasoning (CBR) is a method for solving problems by remembering the same/similar (similar) events that have occurred in the past then using that knowledge/information to solve new problems, or in other words solve problems by facing solutions - solutions that have been used in the past. *Case Based Reasoning* (CBR) has been applied in many different fields and has been tested. Among them: law, medicine, engineering, computing, communication networks, factory design, finance, scheduling, languages, history, food/nutrition, route discovery and the environment[13].

Case Based Reasoning is a knowledge-based problem solving method for studying and solving problems based on past experiences. To produce a solution to a problem, it must carry out several stages of the process where the CBR process must look for similarities in new cases with stored cases, or when there are changes to the solution of a case [14].

Air Conditioner (AC) is a system or machine designed to stabilize air temperature and humidity in a certain area by circulating refrigerant gas through the refrigeration process. Air Conditioner (AC) is a machine that is made to stabilize the temperature and humidity of the air in a room [15].

2. Research methodology

The research framework is a concept or stages that will be carried out in research. So that the steps taken by the author in this design do not deviate from the subject of discussion and are easier to understand, the sequence of research steps will be made systematically so that they can be used as clear and easy guidelines for solving existing problems. The research framework that the authors conducted in the research will be described in Figure 1.

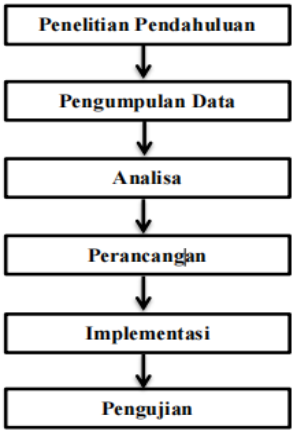

Figure 1. Research Framework

The research stage is a sequence of processes or steps that will be carried out in completing this research. The stages of this research are as follows:

Preliminary research

Identification of the problem is done by approaching the research object . The purpose of this stage is to find out the problems that occur precisely, so that it is hoped that research can provide the most optimal solution to solving these problems. In the world of standardized Air Conditioning (AC), every Air Conditioner (AC) will experience a problem regarding unwanted damage, so the use of time is quite long and continuous without periodic maintenance or use that does not follow the rules for using standardization, so this makes The air conditioner (AC) is damaged. Damage to the Air Conditioner (AC) machine sometimes makes its users have to call a technician who is an expert in this field. Therefore it is necessary to apply an expert system that can diagnose damage to the Air Conditioner (AC).

Data collection

In collecting data, researchers obtain data from various sources such as journals, books and other references to the object of research. This research was carried out by applying the interview method directly to Mr. Jean Hilman's Air Conditioner (AC) Service ,

Data analysis

analysis is carried out to limit the object to be studied so that it becomes information that is more systematic and easy to understand. The data analysis stage is the most important stage in developing a system. At this stage an evaluation and identification of existing problems will be carried out.

Design

At this stage a system will be designed that will be run, starting from analyzing the running system and designing the program that we will run.

Implementation

implementation is the stage of placing the system so that it is ready for use. Implementation aims to confirm the design module, so that users can provide input to developers to develop the system in the future. At this stage the system is created using the PHP and MySQL programming languages

Testing

The testing phase after the expert system application has been designed, a testing and monitoring process will be carried out on the resulting application to find out whether the designed application is running correctly and in accordance with the previously defined problem formulation. This test is carried out to find out whether the expert system can be used in a computerized manner or not . .

3. Results and Discussion

Table 1. Damage Symptoms

Symptom Code	Symptom Name
G01	Accumulation of dust in the condenser
G02	Outdoor AC components heat up quickly.
G03	The outdoor unit is off
G04	There is a sound or noise coming from the AC machine
G05	Hot compressor body
G06	The compressor hums
G07	Hot or faulty condenser
G08	The compressor can start but the starting widing does not come off
G09	Freon Out
G10	The air conditioner emits hot or not cool air even though the fan is on
G11	Porous Condenser
G12	The AC fan doesn't move at all even though the air conditioner is on
G13	Compressor amperage increases
G14	Evaporator cooling is not uniform

The weight criteria used for each symptom of damage. In CBR there is a case representation to determine this. Case Representation is a part that supports Case Based Reasoning. The goal is to describe the problem, describe the solution and the result is a solution to solve the problem. The weight in each suitability criterion for each symptom is determined based on old cases that have been handled.

Table 2. Table of Conformity of Weight for Symptoms

Code and Type of Damage	Symptom Code	Symptom Type	Weight
[K01] Damage to Condenser Fins	G01	Accumulation of dust on the condenser	1
	G09	Freon Out	3
	G11	Porous Condenser	5
[K02] Damage to the compressor	G05	Hot compressor body	3
	G06	The compressor hums	1
	G08	The compressor can start but the starting widing does not come off	3
	G13	Compressor amperage increases	5
[K03] Damage to the capacitor	G04	There is a sound or noise coming from the AC machine	5
	G10	The air conditioner emits hot or not cool air even though the fan is on	5
	G12	The AC fan doesn't move at all though the air	5

		conditioner is on	
[K04] Damage to the Fan (Fan)	G02	Outdoor AC components heat up quickly.	3
	G03	The outdoor unit is off	5
	G07	Hot or faulty condenser	5
	G14	Evaporator cooling is not uniform	3

Table 3. Data Table of Symptoms of Each Damage and Handling Solutions

Crash Code	Symptom Code	Solution
K01	G01 G09 G11	Clean the condenser fins using water mixed with a special cleaning fluid, spray using a steam pump
K02	G05 G06 G08 G13	Check the electrical parts of the house, make sure there are no fluctuations in the electric current, if it does happen frequently it means the compressor is likely damaged and replace it with a new compressor
K03	G04 G10 G12	Replace the capacitor according to size
K04	G02 G03 G07 G14	Clean the fan using a special lubricant. If it can no longer be used, replace the fan with a new one

Weighting is determined based on learning outcomes or observations in cases. The more influential a symptom is on a case, the higher the weight and vice versa. The following is a table of parameter weights.

Table 4. Parameter Weight Table

Symptom Level	Parameter Weight (W)
Important Symptoms	5
Moderate Symptoms	3
Common Symptoms	1

The criterion for case selection is the case which has the highest similarity with the new case which will be suggested as a solution. Even so, every new case does not necessarily have a fairly high similarity value with the case base. Then it is necessary to provide similarity criteria to determine the highest total score. The criteria for dividing the total value are as follows:

Table 5. Table of Similarity Criteria

Percent Value	Similarity Criteria
70-100	Hight
50-69	Medium
0-49	Low

To find out the level of similarity of the four old case examples above with the new case is to match each of the symptoms of the old case with the new one. For example, if the old case 1 has symptoms of AC damage, then a new case also has symptoms of AC damage, it will get a value of 1 and if the symptoms of the old case do not have the same symptoms as the new case, in other words, the symptoms are different, then the value is 0.

Table 6. New Case Table

1	**X..?**	1. Freon Out	?
		2. Accumulation of dust in the condenser	?
		3. The compressor can start but the starting widing does not come off	?
		4. The compressor hums	?
		5. Outdoor AC components heat up quickly	?
		6. The AC fan doesn't move at all even though the air conditioner is on	?
		7. The outdoor unit is off	?
		8. Hot compressor body	?
		9. Evaporator cooling is not uniform	?
		10. There is a sound or noise coming from the AC machine	?
		11. Compressor amperage increases	?

In this process, a similarity calculation is carried out between the old case and the new case as shown below

Calculation of Case 1:

$$similarity\ (X, 01) = \frac{[(1*1)+(1*3)+(0*5)]}{1+3+5}$$
$$= \frac{1+3+0}{9} = 0.44 = 44\%$$

Calculation of Case 2:

$$similarity\ (X, 02)$$
$$= \frac{[(1*3)+(0*1)+(1*3)+(1*5)]}{3+1+3+5}$$
$$= \frac{3+0+3+5}{12} = 0.91 = 91\%$$

Calculation of Case 3:

$$similarity\ (X, 03) = \frac{[(1*5)+(0*5)+(1*5)]}{5+5+5}$$
$$= \frac{5+0+5}{15} = 0.66 = 66\%$$

Calculation of Case 4:

$$similarity\ (X, 04)$$
$$= \frac{[(1*3)+(1*5)+(0*5)+(1*3)]}{3+5+5+3}$$

$$= \frac{3+5+0+3}{16} = 0.68 = 68\%$$

From the calculation above, it can be concluded that the new cases have the highest similarity value of 0.91 or 91%, namely in case 2, it can be concluded that the new cases are symptoms of damage to the compressor ID: 02. The treatment solutions are: Check on the electrical part of the house, make sure there are no fluctuations in the electric current, if it does happen frequently it means the compressor is probably damaged and replace it with a new compressor. To determine similarity criteria, see table 4.5 similarity criteria. So it can be concluded that the results of the similarity criteria of the 4 cases are as follows:

Table 7. Table of Similarity Criteria for the 4 Cases

Crash Code	Damage Name	percent	Similarity Criteria
K01	Damage to condenser fins	0.44	Low
K02	Damage to the compressor	0.91	Hight
K03	Damage to the capacitor	0.66	Medium
K04	Damage to the Fan (Fan)	0.68	Medium

3.1 System Interface Testing

This home page is the main page when opening the expert system for diagnosing AC damage, where menus will appear that can be accessed by the user. The display of the user's home page is presented in Figure 2

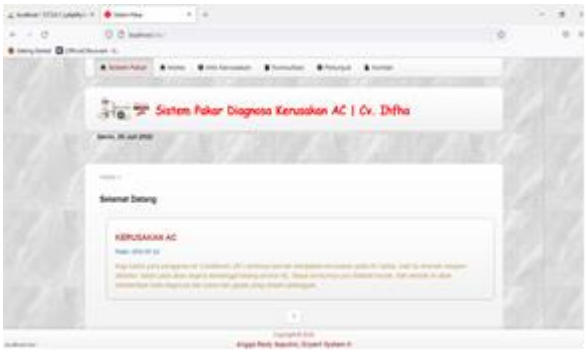

Figure 2 . Display of the User Home Page .

Consultation Page

This page serves as a place to select the symptoms of damage according to the condition of the damage, but before that the user must enter his biodata so that he is directed to the symptoms page. The appearance of the consultation page is presented in Figure 3.

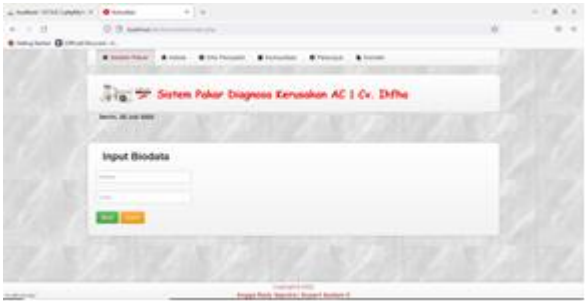

Figure 3 . Consultation Page Display

Symptom Data Page

This page contains symptom data related to damage to the Air Conditioner (AC). The appearance of this symptom page is presented as shown in FIGURE 4 . _

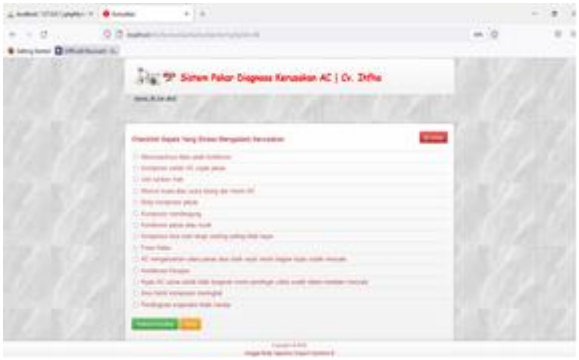

Figure 4 . Symptom Data Page Display

Consultation Result Page

This page contains information on the results of the diagnosis based on the selected symptoms. The display of the results of this consultation is presented as in Figure 5 .

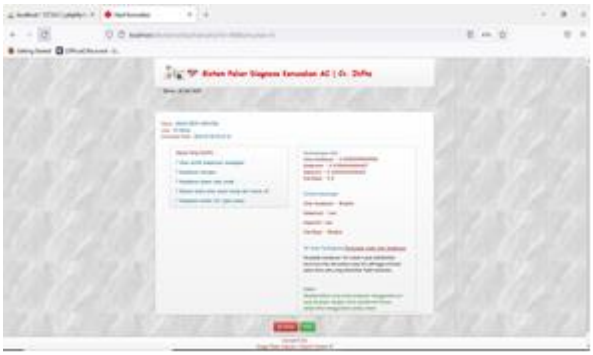

Figure 5 . Display Consultation Results Page

4. Conclusion

With this expert system application that uses the Case Based Reasoning (CBR) method, it is designed to make it easier for AC Service providers to diagnose damage to the Air Conditioner (AC), both in terms of the type of AC damage and the solutions that will be provided. It can help employees work more elegantly and efficiently because all data on damage to the air conditioner already exists in the system, so the owner can find out what damage is to the air conditioner and can be done more quickly. It is hoped that the application of an expert system using the Case Based Reasoning (CBR) method can make the company's operational activities more effective and efficient .

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