Journal of Computer Science and Information Technology
https://jcsitech-upiyptk.org/ojs
2022 Volumes 8 Issue 4 Matter: 131-136 e-ISSN: 2502-1486

Copier Diagnostic Expert System using Case Based Reasoning (CBR) Method

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Abstract

The high need for photocopiers makes machine operations very high for a long time. This situation makes the condition of the machine to be down and easily damaged. This machine is a complex machine that is interconnected with one another , so it needs expert handling in repairing it. The limited number of technicians makes machines that are damaged for a long time to be repaired, so we need a system that can replace the position of experts in repairing copiers. The Case Based Reasoning (CBR) method is a method for building a system that works by diagnosing new cases based on old cases. occurred and provide solutions to new cases based on old cases that have a high similarity value. Just like humans can do reasoning, Case Based Reasoning is developed to do reasoning like humans. With reasoning, Case Based Reasoning can retrieve and equalize past solutions that are stored and used to solve current problems. Photocopiers at Fotocopy Cahaya currently require maximum operational handling due to the high level of use being made. In this research an expert system will be built in light photocopying by applying the Case Based Reasoning (CBR) method. The system built is made up of the PHP programming language and MySQL database to diagnose photocopier damage. The result of this research is a system that can diagnose photocopiers and produce a solution based on the damage experienced by the machine. By implementing an expert system using the Case Based Reasoning method, it will make it easier for Fotocopy Cahaya to diagnose the damage experienced by the machine and find the right solution to overcome the damage.

Keywords : Copy, Expert System, Case based Reasoning, System, Diagnosis .

1. Introduction

A copier is a machine that is used to duplicate documents in paper form to be used for various purposes, the high need for photocopiers makes the machine operate very high for a long time. The situation makes the condition of the machine to be down and easily damaged. A copier is a complex machine that is interconnected with one another , so it needs expert handling to fix it. The limited number of technicians makes machines that are damaged take a long time to be repaired, so a system is needed that can replace expert positions in repairing photocopiers[1].

An expert system (expert system) is a system that seeks to adopt human abilities or knowledge into a computer, so that the computer can work in solving a problem like an expert or someone who has expertise in a particular field, namely an expert who has special knowledge or abilities. unknown and owned by others . Expert systems are a branch of Artificial Intelligence (AI) [2]

The term expert system (expert system) comes from the term knowledge-based expert system. An expert system is a system that uses human knowledge recorded on a computer to solve problems that normally require human expertise. Expert systems are implemented to support problem solving activities [3]

According to (Emha, 2018) declaring CBR is a method for building an expert system by making decisions from new cases based on solutions from previous cases. The Case Based Reasoning (CBR) method is a method for building a system that works by diagnosing new cases based on old cases that have occurred and providing solutions to new cases based on old cases that have a high similarity value [4] .

This research will build an Expert System in Photocopying Light with the Case Based Reasoning (CBR) Method with the PHP programming language and MySQL Database. According to (Mulyana Sri, 2012) Case Based Reasoning (CBR) has become a successful technique for knowledge-based systems in many domains [5]. Case Based Reasoning (CBR) means using previous experience in similar cases to understand and solve problems. Case Based Reasoning (CBR) collects previous cases that are almost the same as new problems and tries to modify the solution to suit the new cases [6].

Case Based Reasoning 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 adapting existing solutions. been used in the past [7].

Received: 03-09-2022 | Revision: 14-09-2022 | Published: 31-10-2022 | doi: 10.35134/jcsitech.v8i4.52

The CBR method is a method that uses experience to solve a problem. Finding similar cases in the past and then reusing them for new problems is the CBR's way of solving problems [8]. The CBR method is applied to determine and define a logical level of confidence to evaluate a possibility. The application of the CBR method in research includes: for predicting the development of chronic diseases [9], diagnosing heart disease [10], diagnosing stroke [11] and many other studies.

Based on the explanation that has been explained, research is needed to facilitate and streamline the work of copier employees in diagnosing photocopier damage in general. Many photocopier users cannot diagnose the damage, so they need computer technicians to handle it and this method of handling is time consuming and costly [12]. With the advancement of expert systems and computer science, the diagnosis of damage to photocopiers is done using a computer system. The photocopier damage diagnostic system is designed using the PHP web programming language combined with the Inference engine, namely the Case Based Reasoning method with a new knowledge base and old knowledge base and adjusting the similarity value so as to be able to provide information on damage to the copier [13] . Diagnostic results can provide information on damage to the copier being diagnosed and the diagnostician will receive information in the form of a solution to handle the damage to the copier [14].

2. Research methodology

To assist in the preparation of this research so that the steps in solving the problems to be discussed can be clearly structured, it is necessary to have a framework arrangement. The research framework contained in Figure 1 is as follows:

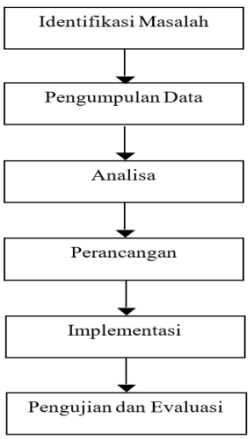


Figure 1. Research Framework

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:

Field Research

This research was conducted by interviewing Daffa who is the owner of Fotocopy Cahaya, asking questions and analyzing problems and obtaining the necessary data.

Research Library (Library Research)

This library research was carried out by reading journals, books, the internet, articles discussing Case Based Reasoning (CBR), and those relating to expert systems. So that the data obtained can be used as a basis for further research stages.

Analysis

Based on the problem identification above, the researcher conducted data analysis first. This is so problem solving can produce new solutions.

System Planning

At the design stage of the expert system using the Case Based Reasoning (CBR) method using the PHP programming language and MySQL database as the output of the system to be run.

System Implementation

The testing method used in this study is the direct testing method, namely by using Black Box testing. Used to test the special functions of the designed software. The correctness of the software being tested is only seen based on the output generated from the data or input conditions.

Testing

This stage will test applications created using the PHP programming language and MySql database. This is done in order to find out whether the application can run according to the design that is done.

3. Results and Discussion

In general, CBR has four stages in solving problems, namely [15] :

1. Retrieve Process
2. Reuse Process
3. Revise Process
4. Retain Process

Table 1. Photocopier Damage Classification Data

Classification Code	Damage Name
K 01	Rubber delivery/Sponge Roll is not rough
K 02	Troubled lasers
K 03	Abnormal hvt units
K 04	Corona Wire/primary charge is dirty/broken
K05	Primary transfer/separation is dirty/broken

Classification Code	Damage Name
K06	Gear 52/45 dirty/broken
K07	Web cleaning runs out
K08	The developing unit is abnormal
K09	Dirty/abnormal motherboard
K10	Abnormal ribbed drum surface/heater element
K11	The heater (heater roll) is loose

From Table 1 above it can be seen that there is a classification code and names of damage that occurred on the copier, which will be used as a proposal for the CBR method.

Table 2. Data on Symptoms of Photocopier Damage

Symptom Code	Symptom Name
G01	Paper does not run from the paper cassette
G02	Paper is pulled double
G03	Continuous/intermittent trips are unstable
G04	Error code 100-002 appears
G05	Black blank results
G06	Plain white results
G07	Error code 061-002 appears
G08	Folded paper under the drum
G09	Error code 061-004 appears
G10	Partially blurry results/blurred results form l...
G11	Background spots on paper surface
G12	Paper does not pass from the roll
G13	Error code 014-005 appears
G14	Error code 005-001 appears
G15	Error code 020-001 appears
G16	Wavy copy results
G17	The results of the copy are uneven/blurred on some of the copies
G18	Error code 315-001 appears
G19	The screen on the monitor does not appear
G20	The machine is not detected current
G21	Spotted copy results
G22	Long line results
G23	The results of the copy are blurry evenly
G24	The results of the copy are not attached to the paper
G25	Error code 350-002 appears
G26	Paper does not pass from try ADF
G27	The paper gets stuck in the delivery rubber
G28	Swing duplex doesn't work
G29	Jamed paper code appears
G30	Machine does not turn on / off completely
G31	Error code 064-002 appears
G32	Several lines appear on the copy

In Table 2 it can be seen that there are 32 symptoms of damage that occurred in the copier.

Table 3. Data on symptoms and weight of photocopy damage

Symptom Code	Crash Code	Weight
G01	K01	0.8
G02	K01	0.4
G03	K01	0.6
G04	K02	1
G05	K02	0.6
G06	K03	0.2
G07	K03	1
G08	K03	0.4
G05	K04	0.4
G06	K04	0.6
G09	K04	1
G10	K04	0.8
G06	K05	1
G08	K05	0.6
G11	K05	0.4
G12	K06	1
G13	K06	0.8
G14	K07	1
G15	K08	1
G16	K08	0.6
G17	K08	0.4
G18	K09	1
G19	K09	0.6
G20	K09	0.4
G21	K10	1
G22	K10	0.4
G23	K10	0.4
G22	K11	0.6
G24	K11	1

Formation of rules (rule) [16]:

RULE 1 : IF the paper does not run from the paper cassette AND the paper is pulled double AND the trip is continuous/unstable THEN the rubber delivery/Sponge Roll is not rough.

RULE 2 : IF the error code 100-002 appears AND the result is a black blank THEN the laser has a problem.

RULE 3 : IF the results are plain white AND the Error code 061-002 appears AND the paper is folded under the drum THEN Hvt unit is abnormal.

RULE 4 : IF black blank result AND plain white result AND error code 061-004 appears AND partially blurry result / blurry result forms l... THEN Corona Wire.

RULE 5 : IF the result is plain white AND the paper has creases under the drum AND the background has spots on the paper surface THEN Primary

RULE 6 : IF the paper does not pass from the roll AND the Error code 014-005 appears THEN Gear 52/45 is dirty/broken.

RULE 7 : IF error code appears 005-001THEN Cleaning web runs out.

RULE 8 : IF the Error code 020-001 appears AND the copy results are wavy AND the copy results are uneven/blurred on some results ... THEN Developping Unit is abnormal.

RULE 9 : IF Error code 315-001 appears AND the screen on the monitor does not appear AND the machine does not detect current THEN The motherboard is dirty/abnormal.

RULE 10 : IF the copy is spotty AND the result is long striped AND the copy is evenly blurry THEN the striped surface of the drum/heater element is abnormal.

RULE 11 : IF the result is long lines AND the copy does not stick to the paper THEN the heater (heater roll) is loose.

Calculations using the CBR method [10]:

1. Calculation of Rubber Damage delivery/Sponge Roll is not rough.

After collecting damage data on the Rubber delivery/Sponge Roll that is not rough what happened to the Light Photocopy, you can see the symptoms of damage in Table 4 as follows:

Table 4 Cases of Damage to Copiers

Code	Damage symptom
G0 1	Paper does not run from the paper cassette
G0 3	Continuous/intermittent trips are unstable
G0 4	Error code 100-002 appears
G 06	Plain white results
G0 8	Folded paper under the drum
G 09	Error code 061-004 appears

Based on the symptoms of damage above, the weight value of the symptoms of damage to the copier can be determined in the table below:

Table 5 Weight of Symptoms of Damage

Initial Symptoms	Weight	Similarity
Paper does not run from the paper cassette	0.8	1
Paper is pulled double	0.4	0
Continuous/intermittent trips are unstable	0.6	1

Determining similarity based on the weight values above, can be seen in the following process:

$$Similarity\ (\ x,x\ ) = \frac{s1*w1+s2*w2+\cdots sn*wn}{w1+w2+\cdots wn}$$

$$Similarity\ (x\ ,k01\ )\ \frac{[\ (1*0.8)+(0*0.4)+(1*0.6)]}{0.8+0.4+0.6} = \frac{1.4}{1.8} = 0.777777777777$$

From the above calculations, the degree of similarity between the new cases and the old cases, namely damage, is obtained rubber delivery/sponge roll is not rough with a percentage of 24.69%.

2. Faulty Laser Damage Calculation

the following damage symptoms :

Table 6 Weight of Symptom Values

Initial Symptoms	Weight	Similarity
Error code 100-002 appears	1	1
Black blank results	0.6	0

Determine the similarity based on the weight values specified above, as follows:

$$Simil\ a\ rity\ (\ x,x\ ) = \frac{s1*w1+s2*w2+\cdots sn*wn}{w1+w2+\cdots wn}$$

$$Similarity\ (x,k02) = \frac{[(1\ *\ 1)\ +\ (0\ *\ 0.6)\ ]}{1\ +\ 0.6} = \frac{1}{1.6} = 0.625$$

From the above calculations, it was found that the level of similarity between the new cases and the old cases, namely the problem of laser damage with a percentage of 19.48%.

3. Calculation of Abnormal Hvt Unit Damage

Data on existing damage symptoms found other damage to the photocopier in Light Photocopy, namely abnormal Hvt Unit damage, which can be seen as follows:

Table 7 Symptom Weight Values from Hvt Units

Initial Symptoms	Weight	Similarity
Plain white results	0.2	1
Error code 061-002 appears	1	0
Folded paper under the drum	0.4	1

Determining similarity (similarity) based on the weight value above, can be processed as follows:

$$Similarity\ (\ x,x\ ) = \frac{s1*w1+s2*w2+\cdots sn*wn}{w1+w2+\cdots wn}$$

$$Similarity(x\ ,k03\ )\frac{[\ (1*0.2)+(0*1)+(1*0.4)\ ]}{0.2+1+0.4} = \frac{0.6}{1.6} = 0.375$$

From the calculation above, the similarity level of new cases with old cases is obtained , namely abnormal Hvt Unit damage with a percentage of 11.90 %.

4. Calculation of Damage Corona Wire/primary charge dirty/broken

Other damage found in the copier, namely damage to the corona wire/dirty primary charge/broken case of the damage can be seen in the damage symptom table as follows:

Table 8 Weight Value of Corona Wire Damage

Initial symptoms	Weight	Similarity
Black blank results	0.4	0
Plain white results	0.6	1
Error code 061-004 appears	1	1
The opaque results form line 1.	0.8	0

Determine similarity based on the above weight values, as follows:

$$Similarity\ (x,x) = \frac{s1*w1+s2*w2+\cdots sn*wn}{w1+w2+\cdots wn}$$

$$Similarity(x,k04) = \frac{[(0*0.4)+(1*0.6)+(1*1)+(0*0.8)]}{0.4+0.6+1+0.8} = \frac{1.6}{2.8} = 0.5714285$$

From the calculation above, the level of similarity between new cases and old cases, namely corona wire damage , is obtained with a percentage of 18.14 %.

5. Primary Damage Calculation

The damage that occurred apart from the damage that was found there was also other damage that occurred to the photocopier, namely Primary Damage which can be seen in the following table:

Table 9 Weight Value of Primary Damage

Initial symptoms	Weight	Similarity
Plain white results	1	1
Folded paper under the drum	0.6	1
Background spots on paper surface	0.4	0

Determine similarity based on the above weight values, as follows:

$$Similarity\ (x,x) = \frac{s1*w1+s2*w2+\cdots sn*wn}{w1+w2+\cdots wn}$$

$$Similarity(x,k05) = \frac{[(1*1)+(1*0.6)+(0*0.4)]}{1+0.6+0.4} = \frac{1.6}{2} = 0.8$$

From the calculation above, the similarity level of new cases with old cases is obtained , namely primary damage with a percentage of 25.40 %.

System Interface Testing

1. Consultation Page

On this page *the user* can select the symptoms of copier damage and the system will process these symptoms to get the diagnosis results.

Figure 2 Consultation Page

2. Consultation Result Page

This page will display the results of consultation diagnoses that have been carried out by *the user* and their handling. *Users* can re-consult and view print results of the consultation. The following is a picture of the consultation results page:

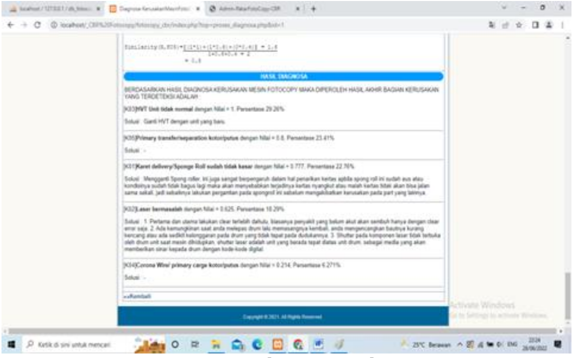
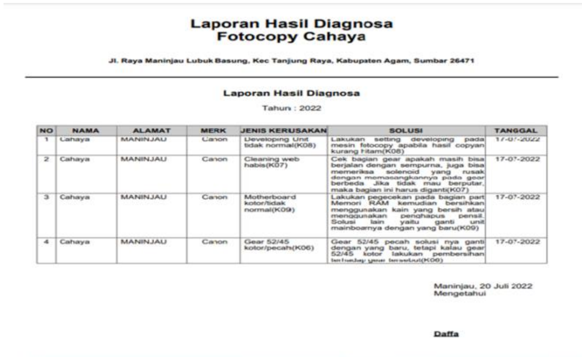


Figure 3 Consultation Results Page

3. Page Report on Diagnostic Results

This page displays the results of the diagnostic process that has been done before. The following shows the diagnostic results report page:



Laporan Hasil Diagnosa
Fotocopy Cahaya

Jl. Raya Maninjau Lubuk Basung, Kec Tanjung Raya, Kabupaten Agam, Sumbar 26471

Laporan Hasil Diagnosa

Tahun : 2022

NO	NAMA	ALAMAT	MERK	JENIS KERUSAKAN	SOLUSI	TANGGAL
1	Cahaya	MANINJAU	Canon	Developing Unit tidak normal(K08)	Lakukan setting developing pada mesin fotocopy apabila hasil copyan kurang hitam(K08)	17-07-2022
2	Cahaya	MANINJAU	Canon	Cleaning web habis(K07)	Cek bagian gear apakah masih bisa berjalan dengan sempurna, juga bisa memeriksa solenoid yang rusak dengan memasangkannya pada gear berbeda. Jika tidak mau berputar, maka bagian ini harus diganti(K07)	17-07-2022
3	Cahaya	MANINJAU	Canon	Motherboard kotor/tidak normal(K09)	Lakukan pegecekan pada bagian part Memori RAM kemudian bersihkan menggunakan kain yang bersih atau menggunakan penghapus pensil. Solusi lain yaitu ganti unit mainboarnya dengan yang baru(K09)	17-07-2022
4	Cahaya	MANINJAU	Canon	Gear 52/45 kotor/pecah(K06)	Gear 52/45 pecah solusi nya ganti dengan yang baru, tetapi kalau gear 52/45 kotor lakukan pembersihan terhadap gear tersebut(K06)	17-07-2022

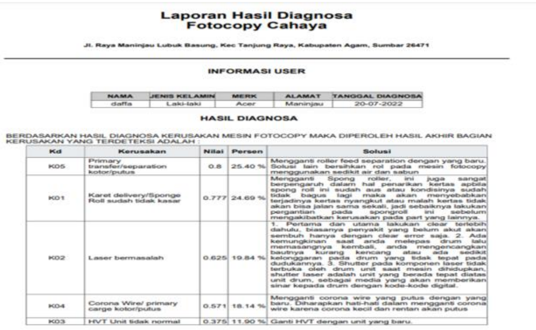
Maninjau, 20 Juli 2022
Mengetahui

Daffa

Figure 4 Diagnostic Report Page

4. User Information Report Page

The user information report page display is a page that displays information such as store name , address, copy brand, type of damage and solution. The following shows the user information report page:



Laporan Hasil Diagnosa
Fotocopy Cahaya

Jl. Raya Maninjau Lubuk Basung, Kec Tanjung Raya, Kabupaten Agam, Sumbar 26471

INFORMASI USER

NAMA	JENIS KELAMIN	MERK	ALAMAT	TANGGAL DIAGNOSA
daffa	Laki-laki	Acer	Maninjau	20-07-2022

HASIL DIAGNOSA

BERDASARKAN HASIL DIAGNOSA KERUSAKAN MESIN FOTOCOPY MAKA DIPEROLEH HASIL AKHIR BAGIAN KERUSAKAN YANG TERDETEKSI ADALAH :

Kd	Kerusakan	Nilai	Persen	Solusi
K05	Primary transfer/separation kotor/putus	0.8	25.40 %	Mengganti roller feed separation dengan yang baru. Solusi lain bersihkan rol pada mesin fotocopy menggunakan sedikit air dan sabun
K01	Karet delivery/Sponge Roll sudah tidak kasar	0.777	24.69 %	Mengganti Spong roller, ini juga sangat berpengaruh dalam hal penarikan kertas apbila spong roll ini sudah aus atau kondisinya sudah tidak bagus lagi maka akan menyebabkan terjadinya kertas nyangkut atau malah kertas tidak akan bisa jalan sama sekali, jadi sebaiknya lakukan pergantian pada spongroll ini sebelum mengakibatkan kerusakan pada part yang lainnya.
K02	Laser bermasalah	0.625	19.84 %	1. Pertama dan utama lakukan clear terlebih dahulu, biasanya penyakit yang belum akut akan sembuh hanya dengan clear error saja. 2. Ada kemungkinan saat anda melepas drum lalu memasangnya kembali, anda mengencangkan bautnya kurang kencang atau ada sedikit kelonggaran pada drum yang tidak tepat pada dudukannya. 3. Shutter pada komponen laser tidak terbuka oleh drum unit saat mesin dihidupkan, shutter laser adalah unit yang berada tepat diatas unit drum, sebagai media yang akan memberikan sinar kepada drum dengan kode-kode digital.
K04	Corona Wire/ primary carge kotor/putus	0.571	18.14 %	Mengganti corona wire yang putus dengan yang baru. Diharapkan hati-hati dalam mengganti corona wire karena corona kecil dan rentan akan putus
K03	HVT Unit tidak normal	0.375	11.90 %	Ganti HVT dengan unit yang baru.

Figure 5 Diagnostic Report Page

4. Conclusion

After implementing a new system, namely an expert system in diagnosing photocopier damage, it is able to diagnose damage that occurs to photocopiers quickly and easily. After applying the Case Based Reasoning (CBR) method in building an expert system it can help copier owners in diagnosing damage to copiers. In order for this expert system to continue to grow and continue to run, maintenance should be done on the system, so that the system can be used on an ongoing basis. Then so that this expert system can produce more accurate data, it is hoped that an update of expert data or expert database (symptoms , damage and solutions) will be carried out.

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