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K-Nearest Neighbor Algorithm and Case Base Reasoning on Xenia Car Damage Detection Expert System

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ABSTRACT

PT Astra Daihatsu Motor or commonly abbreviated as ADM is the Sole Agent Brand Holder (ATPM) of Daihatsu cars in Indonesia. Xenia car is one of the most popular cars in Indonesia. Although there are many Xenia car users, it is not uncommon for Xenia cars to experience damage caused by the ignorance of car users, where the car user only knows how to use it but does not know how to maintain the car properly and correctly. Before damage occurs to the car, the car usually experiences several symptoms of damage that the user does not realize. With that, there are often difficulties experienced by users to find out the type of damage to the car. The purpose of applying and designing applications in this study is to apply the Case Based Reasoning method with the K-Nearest Neighbor Algorithm to detect damage to Xenia cars and to design and build applications with the Case Based Reasoning method with the K-Nearest Neighbor Algorithm to detect damage to web-based Xenia cars. This research uses the Research and Development method. Based on the results of research from previous cases, the new case has similarities with 5 cases and the highest similitude value is with the highest type, namely the type of Injector Malfunction damage with a value of 0.625 or around 62.5%. This expert system application can detect and determine the results of Xenia car engine damage detection by applying a method that looks for the closest similarity value of new cases to old cases, namely the Case Based Reasoning method and the K-Nearest Neighbor Algorithm looking for the closest neighbors of the same weight value. This web-based expert system can be used by users to find the results of Xenia Car engine damage detection experienced by determining the symptoms that are available in web-based applications. This web-based application can also provide solutions from the detection results of the type of Xenia car engine damage.

Keywords: K-Nearest Neighbor Algorithm, Case Based Reasoning, Expert System, Xenia Car Engine Damage

INTRODUCTION

PT Astra Daihatsu Motor or commonly abbreviated as ADM is the Sole Agent Brand Holder (ATPM) of Daihatsu cars in Indonesia. As an ATPM, ADM is the only company that has the right to import, assemble and manufacture Daihatsu branded vehicles in Indonesia. ADM is a *joint venture* company between Daihatsu Motor Company and Astra International that has existed since 1978. Daihatsu branded vehicles sold in Indonesia and marketed by Astra are Daihatsu Zebra, Ceria, Charade, Taft, Feroza, Daihatsu Taruna, Daihatsu Xenia, Daihatsu Terios, Daihatsu Sirio n, Gran Max, Luxio, Daihatsu Ayla, Daihatsu Sigra, and Daihatsu New Rocky. Daihatsu vehicles are fully distributed by Astra through the *Daihatsu Sales Operation* Division which has 137 sales networks throughout Indonesia, of which 71 sales outlets are direct branches of Astra. (Iswara et al., 2021)..

Xenia cars are one of the most popular cars in Indonesia today, this can be seen from the sales data in the first semester of 2022 which has increased up to 2 times from the previous 2 years which in the previous 2 years experienced a drastic decline due to the pandemic. Although there are many Xenia car users, it is not uncommon for Xenia cars to experience damage caused by the ignorance of car users, where the car user only knows how to use it but does not know how to maintain the car properly and correctly. Before damage occurs to the car, the car usually experiences several symptoms of damage that the user does not realize. With that, there are often difficulties experienced by users to find out the type of damage to the car.

In the above problem, sometimes it is also difficult for users to consult about the damage that occurs in their car to the mechanic. This can be caused by insufficient distance and time to consult directly. Mechanics also sometimes have difficulty knowing the problem to determine what type of damage occurs to the car for sure. And time is also an obstacle, because if you find the problem from the damage by disassembling the engine, it can take longer to do the repair.

To overcome the above problems, a damage detection system is needed that can help identify damage to Xenia cars which can later help users know the type of damage, the cause of the damage, and the solution to the damage. This expert system application is not intended to replace mechanics or car experts, but only to help users

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estimate the damage that occurs to the user's car. An expert system is one part of artificial intelligence that can mimic the thought processes and knowledge possessed by an expert with the aim of solving several problems commonly performed by an expert (Efendi et al., 2020).

Previous research is an Expert System for Diagnosing Vehicle Damage to Wuling Confero S Cars Using the Certainty Factor Method. (Nugroho & Sumiati, 2020) conducted research on diagnosing damage to wuling confero s cars. There are 10 types of damage taken and there are 38 types of symptoms of damage to wuling confero s cars. The previous research was an Expert System in Detecting Laptop Damage using the Case Based Reasoning method. (Rahman, 2020)Where in the laptop damage data there are 7 types of damage and there are 51 types of symptoms of damage to the laptop. There is also previous research, namely the Expert System for Diagnosing VGA Damage with the Certainty Factor Method and the K-Nearest Neighbor (K-NN) Algorithm. (Efendi et al., 2020). VGA damage data in this study contained 10 types of damage and 28 types of symptoms on VGA damage.

In this detection system or expert system, researchers use the Case Based Reasoning method with the K-Nearest Neighbor algorithm. The Case Based Reasoning method is a way of calculating by comparing previous cases with new cases using several stages, including *retrieve*, *reuse*, *revise,* and *retain*. The K-Nearest Neighbor algorithm is an algorithm for identifying similarities between new and old data. Then this single algorithm puts the new data into the class that is most similar to the existing class. In other words, K-Nearest Neighbor stores all old data and classifies new data points based on similarities. The application of the K-Nearest Neighbor algorithm to the Case Based Reasoning-based system can provide fast and practical detection results and provide appropriate advice to users to get alternative information for solutions that match the type of damage.

LITERATURE REVIEW

Research conducted by (Malau et al., 2020) which is entitled "Expert System for Diagnosing Non-Matic Motorcycle Damage with the Case Base Reasoning (CBR) Method". The results of this study using the (CBR) method get a success value of 80%. Research conducted by (Setiawan et al., 2020) entitled "Case Based Reasoning Using the K-Nearest Neighbor Algorithm for Handling Ornamental Cupang Fish Diseases". The results of this study are good and the results of the analysis can be accepted by ornamental cupang fish experts and non-expert users. Research conducted by (Via et al., 2021) entitled "Application of Case Based Reasoning and K-Nearest Neighbor Algorithms for Diagnosing Chicken Diseases". The results of this study obtained a disease diagnosis accuracy of 80%. Research conducted by (Rahman, 2020) entitled "Expert System in Detecting Laptop Damage with the Case Based Reasoning Method". The results of this study produce good diagnoses. Research conducted by (Pangestu et al., 2021) which is entitled "Expert System for Diagnosing Amplifier Damage with the Case Based Reasoning (CBR) Method". The results of this study obtained a diagnosis success rate of 80%.

Expert System

An expert system is a computer system that is able to mimic the expertise of an expert. According to some experts, expert systems are a branch of *Artificial Intelligent* (AI) which is quite old because this system began to be developed in 1960. Expert systems or experts in solving problems in certain fields and supported by an *Interference / Inference Engine* that performs reasoning or tracking of something or facts and rules in the knowledge base after searching. (Syaputra, 2019)(Iswara et al., 2021) :. Expert systems are one of the fields of *artificial* intelligence, the definition of an expert system itself is a computer program designed to make decisions like decisions made by an expert, where expert systems use *knowledge,* data and thinking techniques in solving problems that can usually only be solved by an expert from the relevant field. (Sumarno, 2021)(Febriansyah & Winarno, 2021) (Dona et al., 2021).

Case Based Reasoning (CBR)

Case Based Reasoning (CBR) is a method for solving problems by recalling the same or similar events that have occurred in the past and then using that knowledge or information to solve problems by taking solutions that have been used in the past. (Semara Putra & Wibisono, 2020) (Prasetyo & Hadikurniawati, 2021).

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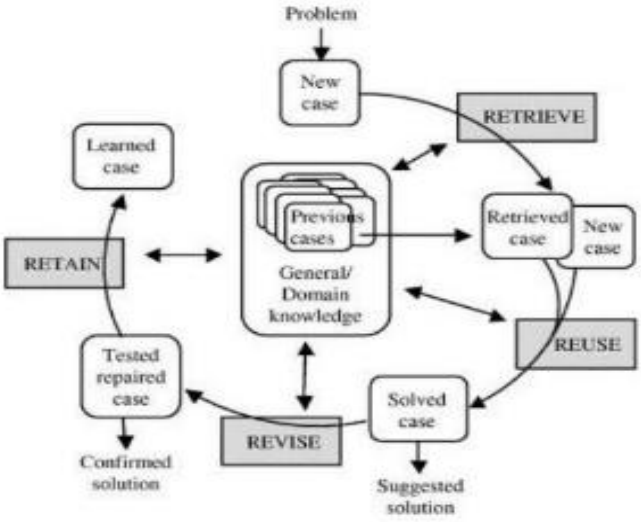

Image 1. Case Based Reasoning Cycle (Asdar et al., 2022)

K-Nearest Neighbor (KNN) Algorithm

The K-Nearest Neighbor (KNN) algorithm is a method for calculating objects based on learning data that is closest to the object. The learning data is projected onto a multi-dimensional space, where each dimension represents a feature of the data. This space is divided into sections based on the classification of the learning data. Nearest Neighbor is an approach to finding cases by calculating the proximity between new cases and old cases, which is based on matching the weights of a number of existing features. (Patasik et al., 2021). The formula for calculating the proximity between two cases is as follows (Setiawan et al., 2020) :

$$\frac{s1\ x\ w1+s2\ x\ w2\ldots+sn\ x\ wn}{w1+w2+\cdots wn} \quad \ldots\ldots (1)$$

Where:
S = similiarity (similarity value) i.e. 1 (same) and 0 (different)
W = weight (weight given)

Closeness is usually between 0 and 1. A value of 0 means that the two cases are absolutely not similar, while a value of 1 means that the cases are absolutely similar.

Xenia car

PT Astra Daihatsu Motor or commonly abbreviated as ADM is the sole agent of Daihatsu car brand in Indonesia. As an ATPM, ADM is the only company that has the right to import, assemble and manufacture Daihatsu branded vehicles in Indonesia. ADM is a *joint venture* company between Daihatsun Motor Company and Astra International that has existed since 1978. Daihatsu branded vehicles sold in Indonesia and marketed by Astra are Daihatsu Zebra, Ceria, Charade, Taft, Feroza, Daihatsu Taruna, Daihatsu Xenia, Daihatsu Terios, Daihatsu Sirion, Gran Max, Luxio, Daihatsu Ayla, Daihatsu Sigra, and Daihatsu New Rocky. Daihatsu vehicles are fully distributed by Astra through the *Daihatsu Sales Operation* Division which has 137 sales networks throughout Indonesia, of which 71 sales outlets are direct branches of Astra. (Iswara et al., 2021).. At this time, there are quite a lot of users of Daihatsu cars with the Xenia brand, but not all users can understand how to maintain their vehicles, most of the vehicle users only understand how to use it without paying attention to how to maintain it. Though by doing maintenance can minimize the occurrence of damage to the car. In addition to motorists, for mechanics it is not the same as regulating the knowledge and experience of each mechanic, mechanics can only guess the damage that occurs in a car. Many technicians sometimes have difficulty detecting damage to vehicles, especially new technicians. (Nugroho & Sumiati, 2020). Car components are a unit that supports the working system of a car engine. The engine moves because of the *internal combustion engine*, which converts chemical energy into mechanical energy by burning a mixture of gasoline and air, resulting in an explosion that can drive the engine. In simple terms, the work process of each component in supporting the overall work includes the charging and internal combustion system, transmission system, steering system, suspension system, brake system, electrical system, and lubrication and cooling system. (Iswara et al., 2021). Because many people do not understand about vehicle engines, it is very necessary to research expert systems related to vehicle damage

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detection. This is useful to help drivers recognize damage to their cars early and provide advice and tips on good vehicle maintenance.

METHOD

The time and implementation of research on the Design of the K-Nearest Neighbor Algorithm and Case Based Reasoning on the Xenia Car Damage Expert System, was carried out at the Diahatsu Medan Krakatau Workshop which is located at Jl. Krakatau Ujung No. 238, Tj. Mulia, Kec. Medan Deli, Medan City, North Sumatra 20241. This research uses the Research and Development method or what is known as the Research and Development method. This method is defined as a research method used to produce certain products and test the effectiveness of these products. In line with this, Sudaryono defines research and development as a process of collecting and analyzing data carried out systematically and logically to achieve certain goals. (Buna & Gobel, 2023). Based on the work framework described above, the discussion of each stage in the research can be described as: Problem Identification, Planning, Data Representation, System Design, Method Application, Implementation, Testing, Results. The discussion of the stages in the research is explained as follows:

1. Problem Identification: At this stage to determine this from the problems contained in the research, so as to find out the problems that exist in the research.
   a. Lack of user knowledge about the damage experienced by the Xenia car.
   b. It is difficult to consult directly with mechanics in a long time and distance.
   c. It takes a lot of time to repair the car if the type of damage is not clearly known.
   d. There is no tool that can detect engine damage to Xenia cars.
2. Planning: Planning is the second stage after knowing the problems that have been experienced by Xenia car users. At this stage, the author has a plan to create a web-based expert system application to make it easier for users to find damage to Xenia Cars, especially in the engine section.
3. Data Representation: At this stage, the author collects data on the types of damage and symptoms that have been experienced by Xenia cars before. In this data representation, the author also gets the rule base of the type of damage and the weight value on the symptoms of damage that have been determined by the expert through interviews.
4. System Design: The design of this system is to detect the symptoms that have been selected by the user so as to obtain the type of damage and the solution to the web-based Xena car engine damage. The system design inputs and designs rules that will be used in determining Xenia car damage solutions based on existing data. The system design also aims as a mechanism between the user and the expert system to consult.
5. Method Application: The system design also applies the Case Based Reasoning method and the K-Nearest Neighbor Algorithm. The application of this method is used in the system to regulate how the system works and how to determine the proximity values of new cases to old cases.
6. Implementation: At this stage, it is expected that this system will be able to solve problems and make it easier for users to find information and solutions regarding Xenia car damage.
7. Testing: At this stage, system testing is carried out in the design of an expert system to find out solutions to Xenia car damage. The system is tested with procedures to perform rule matching. The rules to be matched are existing facts.
8. Results: The use of this web-based Xenia car damage detection tool using the Case Based Reasoning method and the K-Nearest Neighbor Algorithm is very helpful for knowing the type of damage and solutions to the symptoms experienced by Xenia cars.

The following is a Flowchart of this research:

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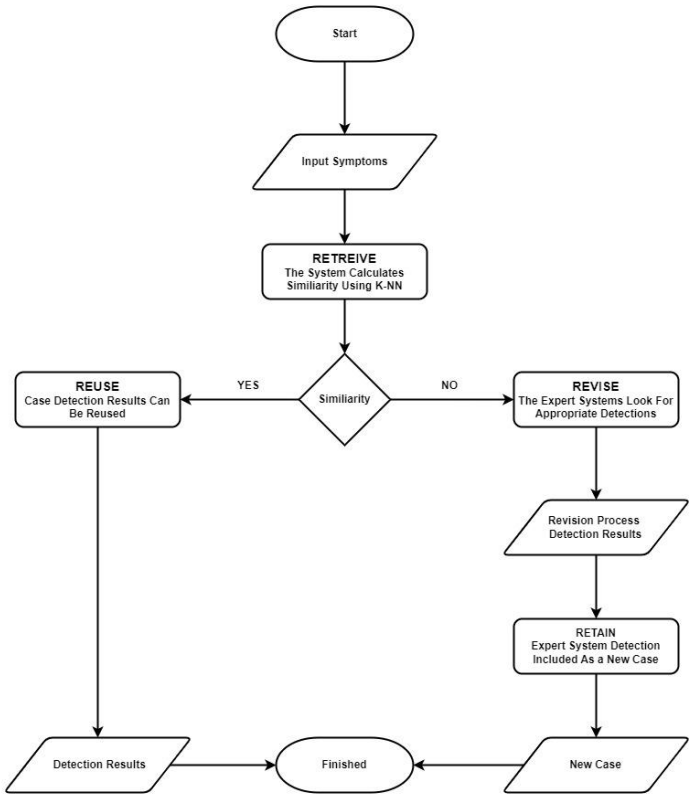

Image 1. System Work Flowchart

RESULT

Planning

At this stage, it will be explained about the application of Case Based Reasoning (CBR) with the K-Nearest Neighbor Algorithm to detect Xenia car damage. Propram implementation using Visual Studio Code. The design aims to detect Xenia car damage and then provide the solution to the user. The author conducted observations and interviews with Mr. Yogi Prayudha as a mechanic at the Diahatsu Medan Krakatau Workshop, so this program was made.

Data Representation

The following list of damage values and damage symptoms is as follows:

1. Types of Xenia Car Damage

The types of damage that often occur in cars are as follows:

Table 1. Types of Damage to Xenia Car

No.	Car Damage	Code
1.	Throttle Body	K01
2.	Fuel Injector Malfunction	K02
3.	Premature Ignition	K03
4.	Engine Overheating	K04
5.	Transmission	K05
6.	Engine Mounting	K06
7.	Spark Plug Damage	K07
8.	Fuel Pump	K08

2. Weighting Categories of Damage Symptoms

Weighting the symptoms of car damage is needed to give a high or low value to the damage that occurs to the car. The weighting value is as follows:

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Table 2. Categories of Damage Symptoms

No.	Categories of Damage Symptoms	Weight
1.	Mild Symptoms	1
2.	Moderate Symptoms	3
3.	Severe Symptoms	5

3. Xenia Car malfunction symptoms

Table 3. Xenia Car Engine Damage Symptoms

Code	Car Engine Symptoms	Weight
G01	Stuttering/Poor Acceleration	3
G02	Bad Idle	3
G03	High RPM	5
..	...	...
G34	Hard to Start	5

4. Rule Base

The rule base is used to determine the type of car damage based on new symptoms. The damage type rule base is as follows:

Table 4. Decision Table

Code	K01	K02	K03	K04	K05	K06	K07	K08
G01	✓	✓						
G02	✓	✓						
G03	✓							
...	...	...	...	...	...	...	...	...
G34								✓

Table 5. Rule Table

No.	*Rule*	Rule Code
1	IF G01 AND G02 AND G03 AND G04 AND G05 THEN K01	R1
2	IF G01 AND G02 AND G05 AND G11 THEN K02	R2
3	IF G06 AND G07 AND G10 AND G33 THEN K03	R3
4	IF G08 AND G13 AND G14 AND G23 THEN K04	R4
5	IF G16 AND G18 AND G19 AND G20 THEN K05	R5
6	IF G15 AND G21 AND G22 AND G29 AND G32 THEN K06	R6
7	IF G24 AND G25 AND G26 AND G27 AND G30 THEN K07	R7
8	IF G09 AND G10 AND G11 AND G12 AND G28 AND G31 AND G34 THEN K08	R8

Application of Case Based Reasoning Method with K-Nearest Neighbor Algorithm

The Case Based Reasoning method is a method for solving problems by recalling the same or similar events (similiarity) that have occurred in the past and then using that knowledge or information to solve problems by taking solutions that have been used in the past. Then the level of similarity is calculated with the new case entered by the user using the K-Nearest Neighbor Algorithm. Based on the level of similarity of these cases, the system will issue a conclusion.

Retrive Process

The Retrive process is a process that retrieves or retrieves the cases that are most similar or relevant to the new case.

New Case Example (X):

Table 6. Symptoms of New Damage

Code	Symptoms of Damage	Weight
G05	Engine Brebet	5
G11	Wasteful Fuel	3
G15	Rough Engine Sound	3
G04	Retained Gas	3

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G30	Car Sudden Death	5

The similitude value in the example above can be calculated by comparing the symptoms contained in the new damage case with the symptoms contained in the old damage case. Then each symptom is weighted with the K-Nearest Neighbor Algorithm. The following is the calculation:

1. Calculating the similarity of new cases with the Throttle Body damage type

Symptoms of Old Cases:

a. Stalled/Poor Acceleration : 3
b. Bad Idle : 3
c. High RPM : 5
d. Retained Gas : 3
e. Brebet Engine : 5

Similitude (X, 01):

$$S = \frac{(0x3) + (0x3) + (0x5) + (0x3) + (1x5)}{3 + 3 + 5 + 3 + 5}$$

$$S = \frac{0 + 0 + 0 + 0 + 5}{19} = \frac{5}{19} = 0{,}42105263157895$$

The similarity value of the new case with the Throttle Body is 0.42105263157895 and percented to 42.105263157895%.

2. Calculating the similarity of new cases with the Fuel Injector Malfunction fault type

Symptoms of Old Cases:

a. Stalled/Poor Acceleration : 3
b. Bad Idle : 3
c. Brebet Engine : 5
d. Wasteful Fuel : 5

Similitude (X, 02):

$$S = \frac{(0x3) + (0x3) + (1x5) + (1x5) + (0x0)}{3 + 3 + 5 + 5}$$

$$S = \frac{0 + 0 + 5 + 5 + 0}{16} = \frac{10}{16} = 0,625$$

The similarity value of the new case with Fuel Injector Malfunction is 0.625 and percented to 62.5%.

3. Calculating the similarity of new cases with Premature Ignition defect type

Symptoms of Old Cases:

a. Tickle Machine : 5
b. Underpowered Mesing : 5
c. Popping sound when releasing the gas : 3
d. Hissing Machine : 5

Similitude (X, 03):

$$S = \frac{(0x5) + (0x5) + (0x3) + (0x5) + (0x0)}{5 + 5 + 3 + 5}$$

$$S = \frac{0 + 0 + 0 + 0 + 0}{18} = \frac{0}{18} = 0$$

The similarity score of new cases with Premature Ignition is 0 and it is percented to 0%.

4. Calculating the similarity of new cases with the engine fault type Overheating

Symptoms of Old Cases:

a. Engine Crashes : 5
b. Hot Air Conditioner : 3
c. High Engine Temperature : 5
d. Oil Mixed with Water : 3

Similitude (X, 04):

$$S = \frac{(0x5) + (0x3) + (0x5) + (0x3) + (0x0)}{5 + 3 + 5 + 3}$$

$$S = \frac{0 + 0 + 0 + 0 + 0}{16} = \frac{0}{16} = 0$$

The similarity score of the new case with Overheating machine is 0 and it is percented to 0%.

5. Calculating the similarity of new cases with Transmission fault types

Symptoms of Old Cases:

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a. Rough sound when releasing the clutch : 1
b. Teeth Like Locked : 3
c. Overdrive Switch On : 1
d. Gear R Can't Reverse : 3

Similitude (X, 05):

$$S = \frac{(0x1) + (0x3) + (0x1) + (0x3) + (0x0)}{1 + 3 + 1 + 3}$$

$$S = \frac{0 + 0 + 0 + 0 + 0}{8} = \frac{0}{8} = 0$$

The similarity score of the new case with Transmission is 0 and is percented to 0%.

6. Calculating the similarity of new cases with Engine Mounting damage types

Symptoms of Old Cases:

a. Starter Doesn't Work : 5
b. Cloudy Battery Water : 3
c. Cranking Less 10 V : 1
d. Rough engine noise : 3
e. Car Shakes at High Speed: 3

Similitude (X, 06):

$$S = \frac{(0x5) + (0x3) + (0x1) + (1x3) + (0x3)}{5 + 3 + 1 + 3 + 3}$$

$$S = \frac{0 + 0 + 0 + 3 + 0}{15} = \frac{3}{15} = 0{,}2$$

The similarity value of the new case with Engine Mounting is 0.2 and is percented to 20%.

7. Calculating the similarity of the new case with the type of damage to the spark plug

Symptoms of Old Cases:

a. Car Sudden Death : 5
b. Residual Lubricant on Spark Plug Heads : 1
c. Crust on the spark plug head : 3
d. Brown Spark Plugs : 3
e. Electrode Melting : 3

Similitude (X, 07):

$$S = \frac{(1x5) + (0x1) + (0x3) + (0x3) + (0x0)}{5 + 1 + 3 + 3 + 3}$$

$$S = \frac{5 + 0 + 0 + 0 + 0}{15} = \frac{5}{15} = 0{,}33333333333$$

The similarity value of the new case with spark plug damage is 0.33333333333 and percented to 33.333333333%.

8. Calculating the similarity of new cases with Fuel Pump damage type

Symptoms of Old Cases:

a. Stuttering Machine : 5
b. Death at High Temperatures : 3
c. Underpowered Engine : 5
d. Difficult to Start : 5
e. Indicator Light Turns On : 3
f. Wasteful Fuel : 5
g. Pungent Fuel Odor : 3

Similitude (X, 08):

$$S = \frac{(0x5) + (0x3) + (0x5) + (0x5) + (0x3) + (1x3) + (0x3)}{5 + 3 + 5 + 5 + 3 + 5 + 3}$$

$$S = \frac{0 + 0 + 0 + 0 + 0 + 5 + 0}{29} = \frac{3}{29} = 0{,}17241379310345$$

The similarity value of the new case with Fuel Pump is 0.17241379310345 and percented to 17.241379310345%.

Based on the search from the previous case, the new case has similarities with 5 cases and the highest similitude value is with the highest type of Injector Malfunction damage with a value of 0.625 or about 62.5%.

Reuse Process

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The calculation of the case above that has the highest similarity weight value is with the type of Fuel Injector Malfunction damage with a value of 62.5%. In the reuse process, the solution provided is the solution that has the highest similarity weight value from the old case to the new case. If the results of the calculation with a similarity weight of less than 60% so it must be revised. The results in percent form can be seen in the following table:

Table 7. Similitude Result Table

No.	Damage Code	Type of Damage	Yield (In Percent)
1	K02	Fuel Injector Malfunction	62,5%
2	K01	Throttle Body	42,105263157895%
3	K07	Spark Plug Damage	33,333333333%
4	K06	Engine Mounting	20%
5	K08	Fuel Pump	17,241379310345%
6	K03	Premature Ignition	0%
7	K04	Engine Overheating	0%
8	K05	Transmission	0%

Revise Process

The revise process is the process of reviewing/improving the solution that has been obtained from the selected problem. If the selected problem does not find the right solution, the revise process will be repeated. But if it does not work again using the revise step, then the information obtained will become a new case and will be evacuated or corrected by the expert to find the right solution. If the revise process succeeds in finding the right solution, the next step is to enter the retain process.

Retain Process

In the revise process, the expert has found the right solution, so in this retain process the admin will enter it into the knowledge base about new case data that has found a solution. From this new case data can be used for subsequent cases with the same problem.

Testing

In this test, the author tests the results of the expert system application in detecting Xenia car engine damage using the Case-based Reasoning method and the K-Nearest Neighbor Algorithm. At the testing stage of this expert system which is designed simply, so that users can easily find information about damage detection quickly and accurately.

Program View

Below is a display of the results and discussion of the expert system for detecting Xenia car damage with the Case Based Reasoning method and the K-Nearest Neighbor Algorithm.

1. Main Page Display

This display appears when the user accesses the web page, on this web page there are four (4) menus namely Home, Information, Consultation and Login. On the home page there is a brief explanation of the Xenia Car Expert System. The display can be seen in the following image:

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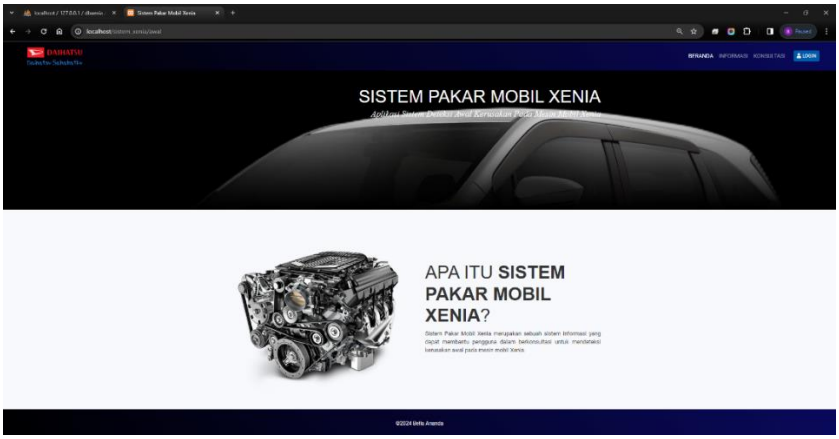

Figure 3. Main Page

2. Information Page Display

This display aims to provide information about the type of xenia car engine damage and solutions that are available on this expert system. The display can be seen in the following image:

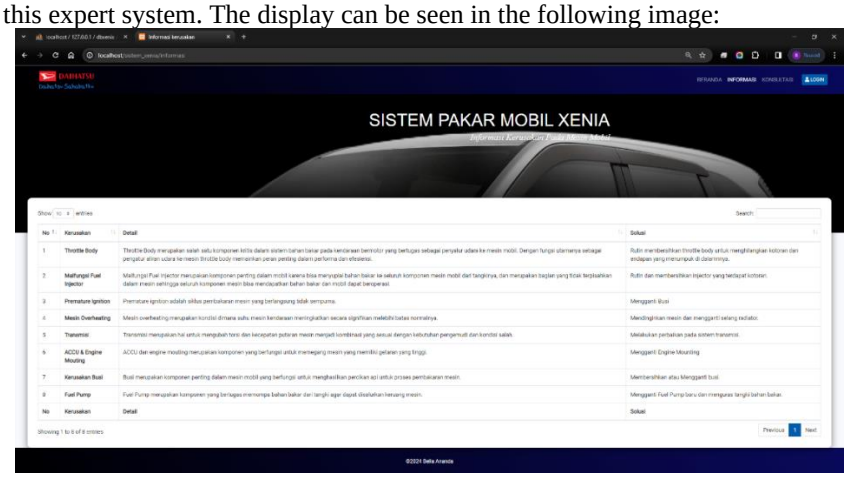

Figure 4. Information Page

3. Admin Login View

This display is used to enter the system, and the admin must fill in the username and password. After entering there are several menus available, namely the Home / Administrator page, Damage, Symptoms, Rules and consultation. The display can be seen in the following image:

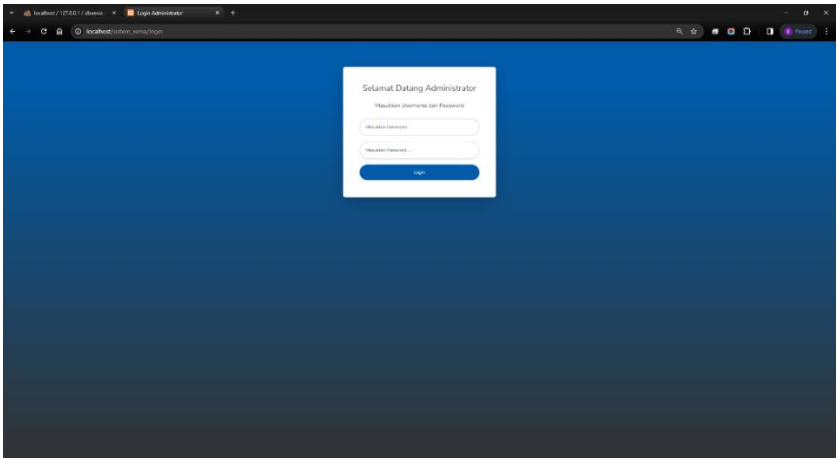

Figure 5. Login page

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4. Home/Administrator Page Display

This display displays the amount of symptom data, damage data and rule data in this system. The display can be seen in the following image:

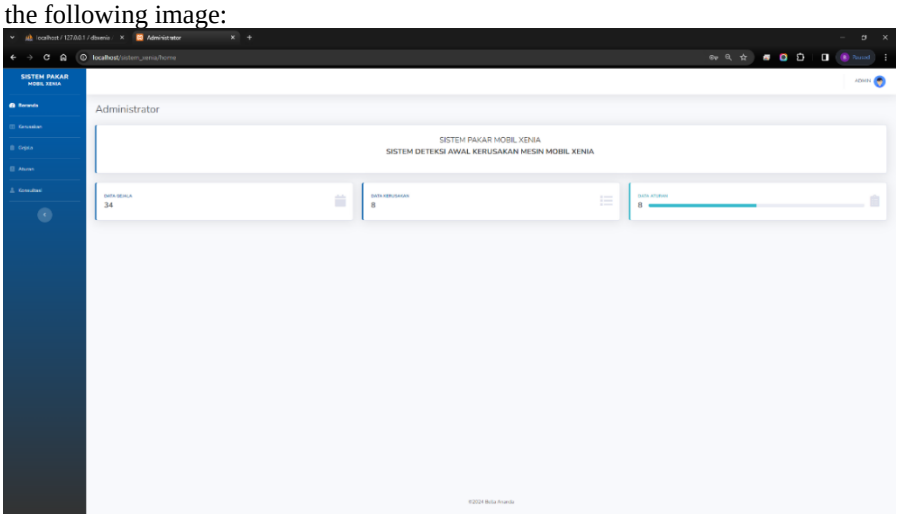

Figure 6. Home/Administrator Page

5. Admin Malfunction Page Display

This view displays a list of damage that has been added by the admin. In this view the admin can change damage and solution data, and can add new data and delete previous data. The display can be seen in the following image:

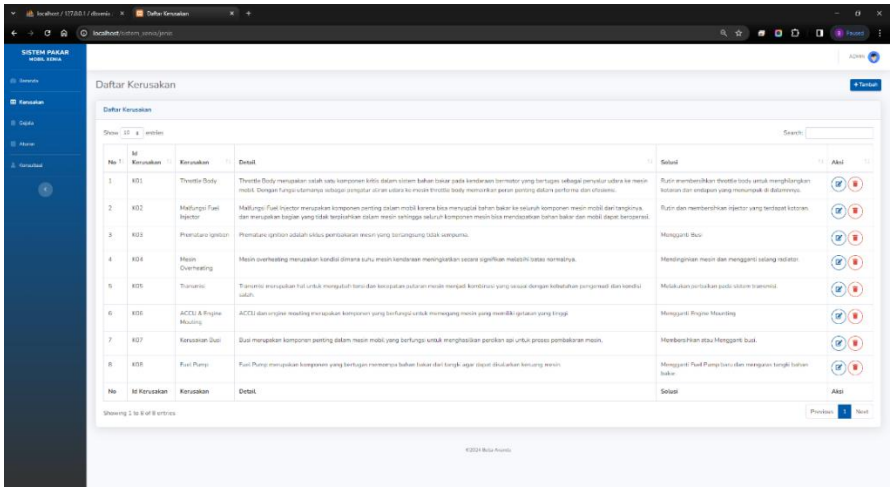

Figure 7. Admin Malfunction Page

6. Admin Symptom Page View

This view displays a list of damage symptoms that have been added by the admin. In this view the admin can delete the type of damage symptoms and add new damage symptoms. The display can be seen in the following image:

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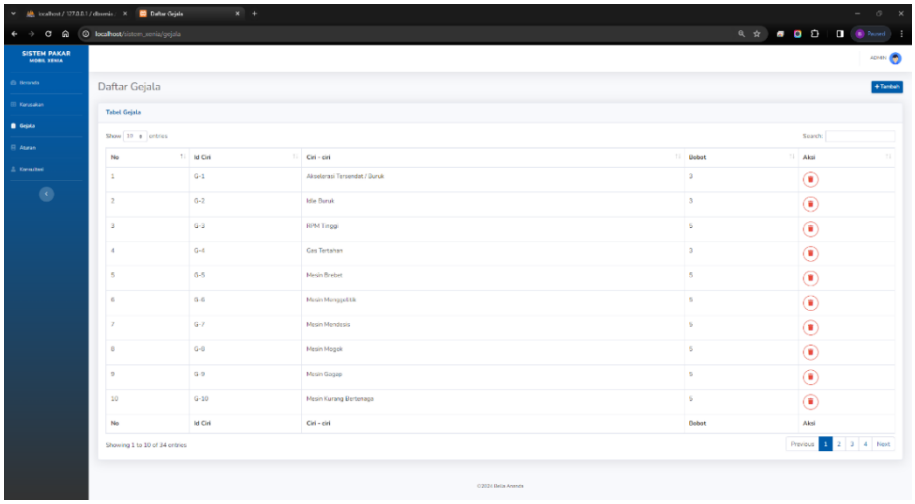

Figure 8. Admin Symptoms Page

7. Admin Rule Page View

This view is a knowledge base view, where this view has details of damage types, symptoms and symptom weight values. In this view the admin can also delete one type of damage, then the symptoms and weight values can be deleted too. The display can be seen in the following image:

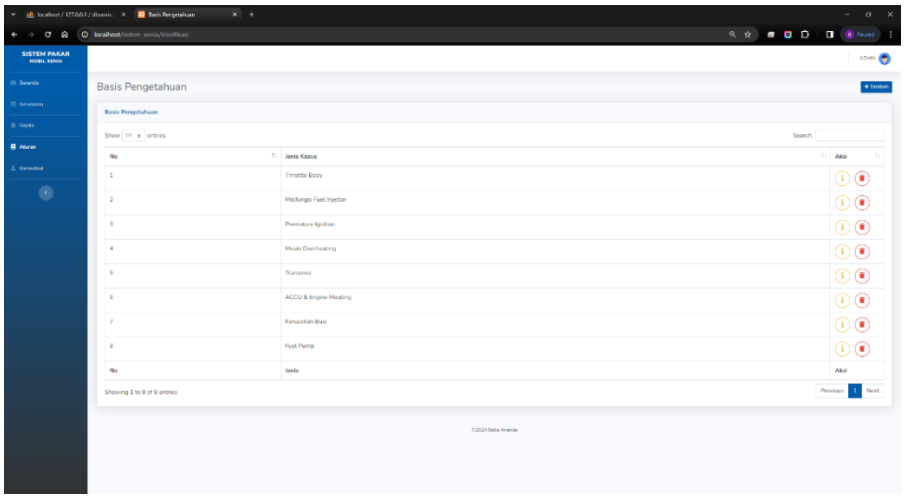

Figure 9. Admin Rules Page

8. Consultation Page View

This display shows Xenia car users who have complaints about engine damage can consult by selecting several symptoms experienced in the user's car. After selecting the user can press the process button in the lower left corner, and the results will be displayed immediately. The display can be seen in the following image:

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Figure 10: Consultation page

9. Consultation Result Page Display

This display shows the detection results as well as the similitude value and type of damage from the symptoms that have been selected by the user to determine the type of damage experienced by the user's car. The display can be seen in the following image:

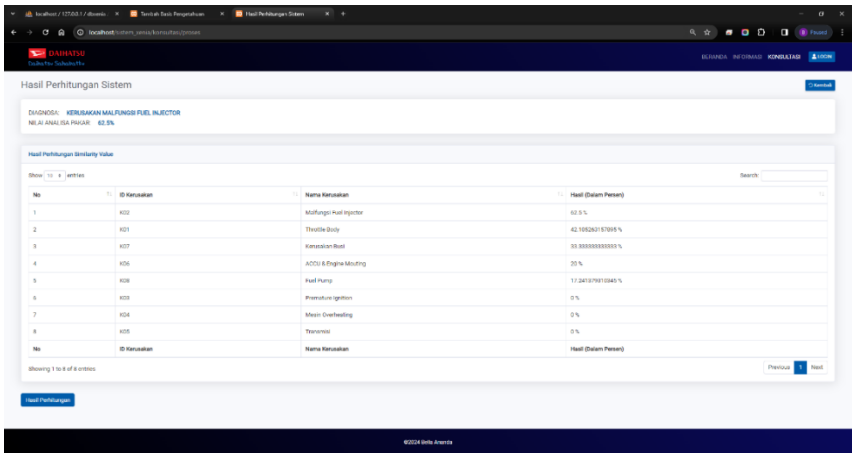

Figure 11. Consultation Result Page

Pros and Cons

This designed car damage expert system has several advantages and disadvantages that have been implemented, namely:

1. The advantages of the designed car fault expert system:
2. This expert system application is very easy to use by Xenia car users to find the type of engine damage experienced by users.
3. This expert system application can also conduct learning for users in analyzing damage, as well as a place for student learning.
4. This expert system application uses the Case Based Reasoning method with the K-Nearest Neighbor Algorithm to detect engine damage by determining the results of several types of engine damage.
5. Disadvantages of car breakdown expert system:
6. This expert system application only recognizes the symptoms of damage to the car engine.
7. This expert system application is only intended for types of damage to Xenia cars.

CONCLUSION

Based on the results and discussion in this study, it can be concluded that this expert system application can detect and determine the results of detecting Xenia car engine damage by applying a method that looks for the closest similarity value of new cases to old cases, namely the Case Based Reasoning method and the K-Nearest Neighbor Algorithm looking for the closest neighbors of the same weight value. This web-based expert system can be used by users to find the results of Xenia Car engine damage detection experienced by determining the symptoms that are available in web-based applications. This web-based application can also provide solutions

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from the detection results of the type of Xenia car engine damage. The author provides suggestions for the development of this application in the future, the expert system application for detecting Xenia car engine damage should be developed by adding types of damage, symptoms and solutions to other items contained in the car. So that users who may not experience damage to the engine can use this expert system application. It is hoped that this expert system application can be developed again in terms of appearance so that it can be more attractive and easy to use. The author also hopes that this expert system application can be developed as an Android-based application, so that it can make it easier for users without opening a web page first.

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