

## APPLICATION OF EXPERT SYSTEM IN DIAGNOSING AUTOMATIC BARRIER GATE DAMAGE USING BAYES THEOREM

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### ABSTRACT

Article Info  
Received, 01/08/22  
Revised, 15/08/22  
Accepted, 30/08/22

An expert system is a computer program that can assist a layperson in resolving an issue by making a decision on a problem based on an expert's response. In general, a worker executes his job in an efficient manner that allows him to save money while working. As a result, most employees and entrepreneurs employ tools that assist humans in doing tasks that are simple and time-saving. There are various things that will require processes that are available at the barrier gate, given the performance power that can pick disconnected elements in the machine. The barrier gate system is a parking crossing facility for everyone who will enter and exit the parking lot at the shopping center through automatic crossing gates, where passengers can open the door first, and a parking data checking procedure using the barcode scanner available at the barrier gate is required. In expert systems, the Bayes theorem approach may be used to diagnose barrier gate damage and compute every conceivable symptom that exists in barrier gate damage. The proposed expert system may be utilized to diagnose existing barrier gate deterioration.

Keywords: Barrier gate, Expert System, Bayes' theorem

### 1. INTRODUCTION

In the global era like today, electronics and control are progressing very rapidly and are revolutionizing very quickly through their means or media. Electrical technology also conveys a kind of donation for human life with the very rapid development in this field. There are so many types of tools that have been made by humans to fulfill dreams and needs when carrying out all activities, where the role of electrical equipment is quite important in technological developments. At this time, the field of electronics is needed because in this field there are several systems that can help facilitate human work, one of them is automatic gate control (Automatic Barrier Gate), especially in large shopping centers where when parking vehicles most shopping centers currently use automatic doors when entering and exiting the parking lot. In an effort to support these facilities, science and technology play a very important role. "An expert system is a system that is able to imitate the reasoning of a computer expert to solve problems that are usually done by experts. Knowledge stored in expert systems is generally taken from a human who is an expert in the problem. The important role of an expert can be replaced by a computer program which in principle works to provide a definite solution as is usually done by experts. (Hasibuan et al., 2017)" The dominance of science and technology is expected to make progress, which in the end can be used appropriately and usefully. This study aims to diagnose some of the damage that often occurs in automatic barrier gate machines. This research is expected to be able to provide good diagnostic results so as to get the right solution to be applied in repairing damage to the automatic barrier gate machine. Based on the description of the background, the authors are interested in conducting research on the diagnosis of automatic door damage in shopping centers, the authors raise the title Application of Expert Systems in Diagnosing Automatic Barrier Gate Damage Using the Bayes Theorem Method.

## 2. METHOD

In this literature study, the author conducted several studies or reviews on things similar to this writing through journals and related articles that intersect with the decision-making system. Some of these journals are summarized below:

"Research conducted by Hengki Tamanda Sihotang, Erwin Panggabean, and Herlina Zebua entitled Expert System Diagnosing Herpes Zoster Using Bayes' Theorem Method in 2018 where Herpes Zoster is a skin disease that is very difficult to treat and everyone must be can experience it, the characteristics of this disease is characterized by the presence of unilateral vesicular clusters with pain characterized by radicular around the dermatome. This study aims to develop the Bayes theorem method using Visual Basic 2008 as a tool for diagnosing skin diseases. With this application, you don't have to wait long to anticipate treatment quickly and precisely. How to use this application, the admin inputs questions in the form of symptoms experienced by patients, then the system will process all the patient's answers using the Bayes method and the system will issue an output in the form of a diagnosis of the type of disease. The system built can assist patients in knowing the type of disease that the patient is suffering from and in accordance with the analysis of skin disease experts."(Sihotang et al., 2018)

"Further research is a study conducted by Puji Sari Ramadhan entitled Expert System for Diagnosing Immune Dermatitis Using Bayes' Theorem in 2018 where Immune Dermatitis Disease is a skin disease that mostly affects infants and children which causes weakening of the immune system. because the immune system is still weak in children so it is very easy to be attacked by viruses and bacteria, but at this time the lack of public knowledge about Immune Dermatitis disease results in the difficulty of early detection of the disease, causing delays in handling children with Immune Dermatitis. Seeing the phenomena that occur, it takes an intelligent system that is able to adopt the skills and knowledge of experts into a computerized system to produce an accurate diagnostic analysis using the Bayes theorem method, which has been known that this method has been widely used to diagnose diseases in several cases. ."(Ramadan, 2018)

"The next research from Acihmah Sidauruk, Ade Pujianto entitled Expert System for Diagnosing Diseases of Palm Oil Plants Using Bayes' Theorem in 2017, where oil palm is one of the plants that has its own charm in the community. Currently, oil palm plantations in Indonesia are growing very rapidly. Oil palm is grown and cultivated almost all over the archipelago, whether it is owned by individuals or owned by companies. This plant contains many properties that make the demand for oil palm continue to increase. An expert system is a branch of artificial intelligence that uses specialized knowledge to solve problems at the expert level. One application of the expert system is in the field of plantations to diagnose diseases in plants. In this study, the design and manufacture of an expert system used to help diagnose a disease in oil palm plants and determine suggestions or treatment solutions for oil palm plants. The final result of this paper is an expert system for diagnosing oil palm plant diseases along with the probability value of the diagnosed disease that shows the level of system confidence in the disease and suggestions or treatment solutions for the oil palm plant.(Acihmah Sidauruk, 2017).

### a. Expert system

The expert system is part of artificial intelligence (AI) which is quite old because this system was developed in 1960. The expert system that first appeared was the General Purpose Problem Solver (GPS) developed by Newel Simon. The term expert system comes from the term knowledge-based expert system. This term arises because to solve problems, expert systems use the knowledge of an expert that is entered into a computer. Someone who is not an expert uses an expert system to improve problem solving skills, while an expert. An expert system is a computer program that represents and performs reasoning with the knowledge of several experts to solve problems or provide suggestions.(Ramadan, 2018)

### b. Bayes' Theorem

This method can be defined as one of the methods contained in the Expert System which is used to generate conclusions based on the calculation of the possible values of the facts that occur. In

addition, in international journals it is stated that the Bayes theorem is a concept of right and wrong probability rules that can be processed into additional information or knowledge.(Ramadan & Arif, 2019)

The following is a formula for Bayes' theorem:

$$P(H|E) = \frac{P(E|H) \cdot P(H)}{P(E)} \dots\dots\dots(1)$$

Information :

P(H | E): the probability of the hypothesis H if given evidence of E.

P(E | H): the probability that any evidence will appear.

P(E) : probability of evidence E(Ramadan & Arif, 2019)

c. Barrier Gate

Barrier gate is a tool that can be used for parking portals automatically. Usually this tool is used in crowded parking areas. This barrier gate works automatically to open and close the bars. To open the parking barrier, you can use the control system or you can also use the remote to open it. The speed of opening or closing the bars depends on the specifications of the barrier gate used. To automatically close the parking bars, sensors are added to detect incoming and outgoing vehicles so that accidents do not occur when closing the bars. The sensor used detects metal in the vehicle.(Bustami, 2018).

d. System Design

The system design in the designed application can be seen from the flow diagram as follows:

a. Flowchart diagrams

The flowchart diagram at this writing can be seen from Figure 1 below:

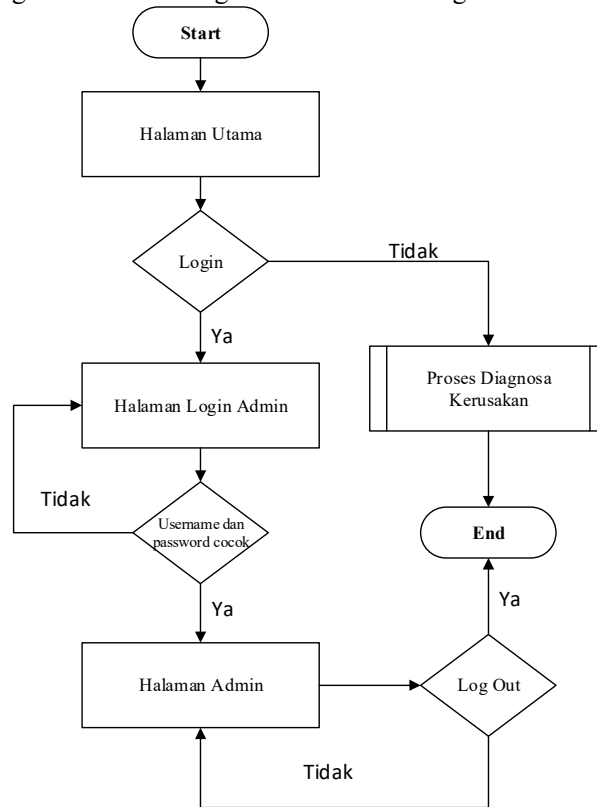


Figure 1. Flowchart of the running system

b. Activity diagrams

Use case diagrams describes the functional relationships expected from the design of a system. In this case, the emphasis is on what the system can do, not how the system can do it. A use case describes an interaction that occurs between the actor and the system. A use case is a specific job, for example a user login to the system, inputting damage data, problem data and so on. The Use case diagram in the design of this system can be seen in Figure 2 below.

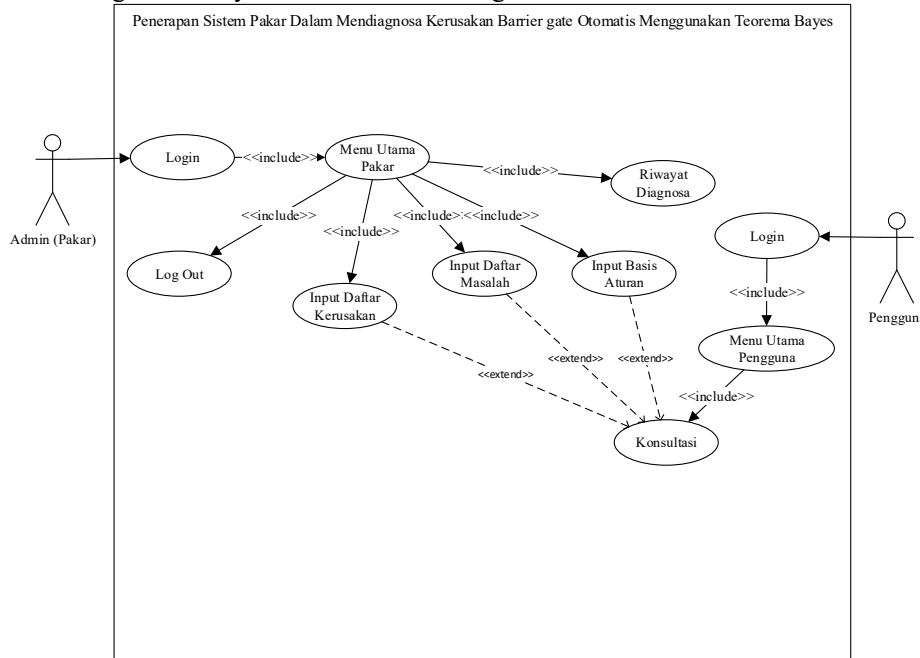


Figure 2. Use Case Diagram System

**3. RESULTS AND DISCUSSION**

The barrier gate machine is an automatic door machine that has a function to open the crossing path in the vehicle parking lot. This machine works as long as the shopping center is open, in other words this machine has a non-stop working system. In the process of working, this machine is often damaged several times. Checking for damage to this machine is still done manually, namely by calling a technician to check for damage to the machine. This can hamper the performance of parking managers at shopping centers because the damage to this machine makes the queue of visitors long. To overcome these problems, researchers will try to create a system that can track engine damage so that the repair process becomes faster.

Before calculating Bayes' theorem, first determine the symptoms, damage, and rules that will be used as follows:

Table 1. Symptom

Code	Symptoms	Symptom	Density
G01		Boarding Pass Not Responding To Scanner	0.7
G02		Door Can't Open	0.9
G03		Slow Door Response	0.8
G04		Scanner Not Working	0.9
G05		The Barrier Gate doesn't want to close like it used to	0.7
G06		Gate Not Listed In Boarding Pass	0.8
G07		Parking card number and date do not match on scanner	0.8

Table 2. Machine Damage

Fault_code	Damage	Solution
P01	Led Sensor Light Not Responding To Scanner, Boarding Pass Paper Damaged.	Checking on Door Sensors. Replace Led Sensor Light On Auto Gate. Double-check the Boarding Pass Paper.
P02	The door is damaged because it is forced, the system data has not been inputted or the data has not matched the boarding pass	Double Check the Data On the Boarding Pass Computer. Don't Force the Barrier Gate to Open.

Table 3. Rules

No	Rules
1	IF G01 AND G02 AND G03 AND G04 IS TRUE THEN P01
2	IF G01 AND G02 AND G03 IS TRUE THEN P01
3	IF G05 AND G06 AND G07 IS TRUE THEN P02
4	IF G06 AND G07 IS TRUE THEN P02

After determining the symptoms, damage, and rules, then the next step is to make an example of calculating Bayes' theorem for symptoms. The admin or system user will be given questions that must be answered and the admin or user has answered the following questions:

$$G01 = 0.7 = P(E|H1)$$

$$G02 = 0.9 = P(E|H2)$$

$$G03 = 0.8 = P(E|H3)$$

$$G04 = 0.9 = P(E|H4)$$

The next step is to find the universal value by adding up from the above hypotheses:

$$\begin{aligned} \sum_{k=1}^4 &= G01 + G02 + G03 + G04 \\ &= 0.7 + 0.9 + 0.8 + 0.9 \\ &= 3.3 \end{aligned}$$

After the results of the sum above are known, the formula for calculating the universe value is as follows:

$$P(H1) = \frac{H1}{\sum_{k=1}^4} = \frac{0.7}{3.3} = 0.2121$$

$$P(H2) = \frac{H2}{\sum_{k=1}^4} = \frac{0.9}{3.3} = 0.2727$$

$$P(H3) = \frac{H3}{\sum_{k=1}^4} = \frac{0.8}{3.3} = 0.2424$$

$$P(H4) = \frac{H4}{\sum_{k=1}^4} = \frac{0.9}{3.3} = 0.2727$$

After the P(Hi) value is known, the probability of the hypothesis H regardless of any evidence, then the next step is:

$$\begin{aligned} \sum_{k=1}^4 &= P(Hi) * P(E|Hi - n) \\ &= (P(H1) * P(E|H1)) + (P(H2) * P(E|H2)) + (P(H3) * P(E|H3)) + \\ &\quad (P(H4) * P(E|H4)) \\ &= (0.2121 * 0.7) + (0.2727 * 0.9) + (0.2424 * 0.8) + (0.2727 * 0.9) \end{aligned}$$

$$= (0.14847) + (0.24543) + (0.19392) + (0.24543)$$

$$= 0.83325$$

The next step is to find the value of  $P(H_i|E)$  or the probability that the hypothesis  $H_i$  is true if given evidence of  $E$ .

$$P(H_1|E) = \frac{0.7 * 0.2121}{0.83325} = 0.17819$$

$$P(H_2|E) = \frac{0.9 * 0.2727}{0.83325} = 0.2945$$

$$P(H_3|E) = \frac{0.8 * 0.2424}{0.83325} = 0.233$$

$$P(H_4|E) = \frac{0.9 * 0.2727}{0.83325} = 0.2945$$

After all the values of  $P(H_i|E)$  are known, then add up all the Bayes values with the following formula:

$$\sum_{k=1}^4 Bayes = Bayes1 + Bayes2 + Bayes3 + Bayes4$$

$$= (0.7 * 0.17819) + (0.9 * 0.2945) + (0.8 * 0.233) + (0.9 * 0.2945)$$

$$= 0.841233 * 100\% = 84.12\%$$

So based on the symptoms that have been given, it can be concluded that the machine is damaged, Led Sensor Light Doesn't Respond To Scanner, Boarding Pass Paper is Damaged with a certainty level of 84.12%.

#### a. Prototype Implementation

The following is the display of the application prototype that the author designed to facilitate the application of the Bayes theorem method in identifying damage to the barrier gate machine.

##### 1. Home Menu Display

The homepage is an interface that connects the user with other forms. The home form contains menus that can be selected by clicking on the desired menu section. The appearance of the homepage form can be seen in Figure 3 as follows:



Figure 3. Home menu display

##### 2. Symptoms Data Menu Display

Form Symptom data contains data about the symptoms of the automatic gate machine malfunction. The operations contained in this form are: Save, Search, Update, Delete, and Exit. The display of the symptom data form can be seen in Figure 4 as follows.



Figure 4. Symptom Data

### 3. Display of the diagnostic result form

The display of the diagnostic results form contains the results of the diagnostic process that has been carried out previously. The display of the diagnostic result form can be seen in Figure 5 as follows:



Figure 5. Diagnostic Results

## 4. CONCLUSION

Based on the results of the discussion, conclusions can be drawn, among others, as follows: This research has succeeded in producing an expert system application that is designed to be integrated with the database as a place to store data. The application of the Bayes theorem method can be used in an expert system in diagnosing damage to the barrier gate to calculate every possible symptom that exists in the damage to the barrier gate. The application of the designed expert system can be used to diagnose existing damage to the barrier gate.

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