SITEKIN: Journal Sains Teknologi dan Industri, Vol. 20, No. 2, June 2023, pp.940 - 949
ISSN 2407-0939 print/ISSN 2721-2041 online

Expert System Application Design for Diagnosing Damage to The Charger Rectifier Panel with A Website-Based Forward Chaining Method

Firman Robianto[1], Entis Sutrisna[2]
Computer Science, Universitas Pamulang, Indonesia
Email : firmanroby07@gmail.com, dosen00639@unpam.ac.id

ABSTRACT

In the increasingly complex world of work, as technology and information continue to evolve, there is a need for a medium that can leverage information to support business processes or activities in an organization, making them more effective and efficient. PT. Swadaya Engineering, a company operating in the electrical and telecommunications industry located in South Jakarta, is facing a problem of frequent damage reports on rectifier charger panels that are difficult to convey manually through phone calls. This constraint is a hindrance to improving the effectiveness and efficiency of the company, causing customer dissatisfaction due to a lack of information obtained. To address this issue, the author developed an expert system application for diagnosing rectifier charger panel damage based on a website using forward chaining as the application development method. The purpose of designing this application is to improve the effectiveness and efficiency of the company in delivering information on rectifier charger panel damage and increasing customer satisfaction in diagnosing such damage. It is expected that this expert system application will be an effective medium for the company to leverage information and support business processes or activities that are carried out.

Keywords: *Expert System, Forward Chaining, Panel Rectifier Charger, Website*

Introduction

The development of technology and information in the current era of globalization is very rapid. This requires companies and other agencies to have qualified information processing technology, one of which is information systems. Information systems are mandatory for every company in managing its business because this system can provide information needed by management in making decisions [1]. However, not only information systems are used in information processing. There is also another technology that is expected to provide ease and speed in making decisions, namely expert systems [2].

An expert system is a computer program in the field of artificial intelligence designed to provide decisions, in which the expert system uses knowledge, facts, and thinking techniques in solving problems. In this case, the expert system acts as a consultant who can provide conclusions in overcoming a problem by combining knowledge and data exploration. The application of expert systems can be applied in various fields, such as medical and managerial fields [3].

In the medical field, expert systems can be used to diagnose diseases according to the symptoms experienced by patients. While in the managerial field, expert systems can help analyze, synthesize, and integrate data to build a company. With the expert system, it is expected that companies can make decisions effectively and efficiently in dealing with various problems that arise [4].

PT. Swadaya Engineering is a company engaged in electricity and telecommunications. This company has been established since 2001 and has experience in producing various kinds of electrical devices such as Battery Charger / Rectifier, Battery Charger Mobile, Fault Detector, High Current Discharge, and Voltage Dropper. The company cooperates with state-owned company PLN, petrochemical industry, onshore/offshore, fire alarm systems, turbine control and other private companies. One of the superior products from PT. Self-help Engineering is a Panel rectifier charger, a device that functions to convert AC electric current into DC current [5].

However, in its use, the Panel rectifier charger requires routine maintenance in order to function properly and minimize damage to the device. Unfortunately, currently PT. Self-help Engineering experienced problems in terms of lack of adequate manpower, causing many damage reports received by customer service.

This is due to the customer's lack of knowledge of the charger rectifier panel, making it difficult for field technicians to diagnose damage and repair it quickly [6].

This problem resulted in a long time in overcoming the damage to the charger rectifier panel, because in processing the damage diagnosis data received by customer service was not accurate. Therefore, companies need to increase customer knowledge about Panel rectifier chargers and also increase adequate manpower so that maintenance and repair of electrical devices can be carried out more efficiently and accurately, so as to provide better service to customers. The purpose of writing in conducting this research is to design an expert system application as the initial stage of customer consultation in overcoming damage to the charger rectifier panel. Cut repair time to be more efficient. And make it easier to process damage data on the charger rectifier [7].

Research Methods

Data Collection Techniques

Data collection techniques aim to obtain accurate data in writing. This research was conducted with the following data collection methods [8]–[11]:

1) Observation (Observation)
   Observation directly observes the activities that are happening in the report of damage to the charger rectifier at PT. Self-help Engineering, so as to know complete and accurate data and information.
2) Interview
   By conducting direct interviews with technical experts in order to analyze the running system.
3) Literature Study
   In collecting data, the author analyzes with reference books related to research and problems loaded.

System Design Techniques

System design techniques used in making expert system applications to diagnose damage to the charger rectifier panel, namely using the Extreme Programming (XP) method. According to Candra in the journal XP is one of the software development techniques that is quite simple, communication, and good feedback [12].

The stages in designing an expert system application to diagnose damage to the charger rectifier panel at PT. Self-help Engineering with extreme programming methods is explained as follows [13]–[19]:

a. Planning
   In the construction of an expert system for diagnosing damage to the charger rectifier panel at PT. Self-help Engineering carried out at this stage starts from identifying problems faced in the running system, then analyzing user needs for the system to be built.
b. Design
   At the design stage, a model system is made based on the results of the analysis in the previous stage. Database modeling made at this stage aims to describe the relationship between data or between processes to be carried out. System modeling is done using Use Case Diagram, Activity Diagram, Component Diagram and Deployment Diagram.
c. Coding
   After the design stage is complete, coding is carried out by means of the design stage implemented into the expert system program code. In making expert system programs using PHP programming language combined with HTML, CSS, JavaScript and using MySQL in database creation.
d. Testing
   At this stage, testing the overall functionality of the expert system is carried out. The method used in this test uses the Black Box Testing and White Box Testing methods, namely by testing the inputs and outputs of the expert system application.
e. Software Increment (Peningkatan Perangkat Lunak)
   This stage is a system development that has been made in stages that aims to improve the functionality of the system. At this stage it is done if there is a change in functionality in the system but this research is not done because the software is still new and still in use.

Results and Discussion

Application Design

Use Case Diagram

According to Sukamto and Salahudin in the journal explained that use case diagrams are modeling a behavioral trait (behavior) in an information system to be created. [20] Use Case Diagram is a description of interactions between application components that introduces how they interact with users.

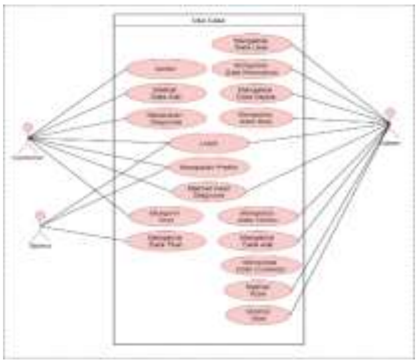

Figure 1. *Use Case Diagram*

Activity Diagram

Activity diagrams illustrate the business process or workflow activities of a system by the software being designed. The procedural logic and workflow of the expert system application design are described in the activity diagram below:

1. Activity Diagram List

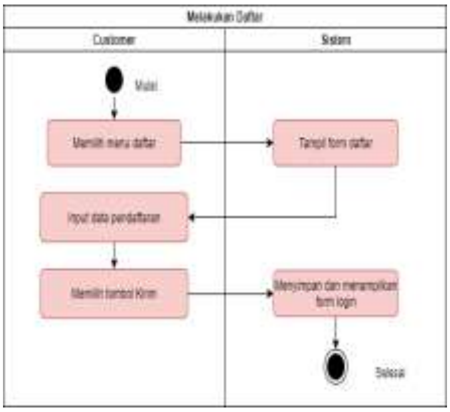

Figure 2. *Activity Diagram* List

2. Activity Diagram Login

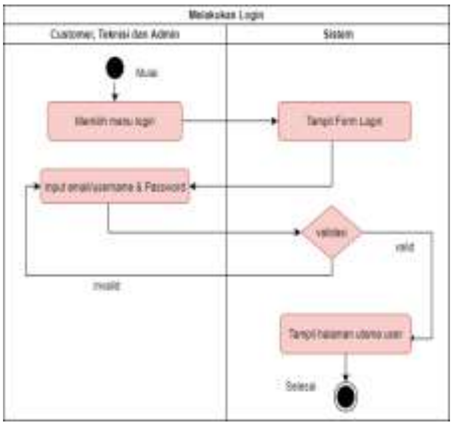

Figure 3. Activity Diagram Login

Sequence Diagram

According to Sukamto and Salahudin in the journal explain the sequence diagram describes an interaction between objects involved in and around the system described against time. The following [21][22] is a sequence diagram of the expert system application design:

1. Sequence List
   Sequence: List
   Actor: Customer

Description: User could perform lists by selecting the register menu and inputting the required registration information.

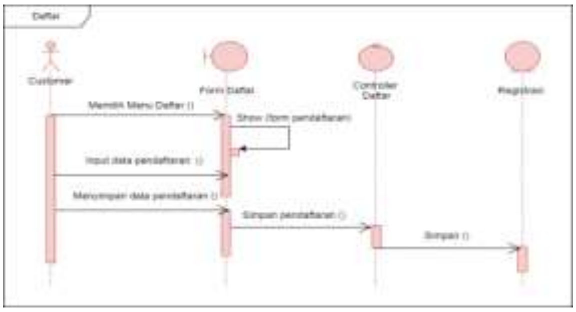

Figure 4. List Sequence Diagram

2. Sequence Login
   Sequence : Login
   Actor : Customer, Technician and Admin
   Description : User can login

By filling in the email and password then pressing the login button and passing the validation process to and if successful it will display the main admin menu. If it fails, a notification will appear and return to the login page.

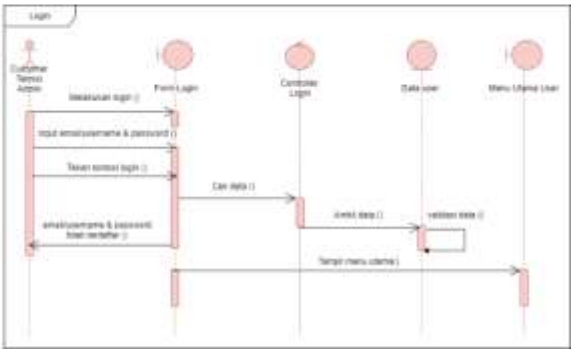

Figure 5. Login Sequence Diagram

Implementation

Implementation is an action or activity that has been carefully and detailed (mature) and the advanced stages of system design to be carried out, including programs that have been made to be ready to operate optimally according to needs.

System *Interface*

1. *Home Customer*

Figure 6. *Home Customer Interface*

Is the initial display when opening the *customer's home* page *website*.

2. Information

Figure 7. *Information Interface*

Is the display of the information menu, this page can be accessed by clicking the information button on the menu.

3. List

Figure 8. *List Interface*

It is a list page display, on this page customers can register by filling in personal data in accordance with the existing form.

4. Login

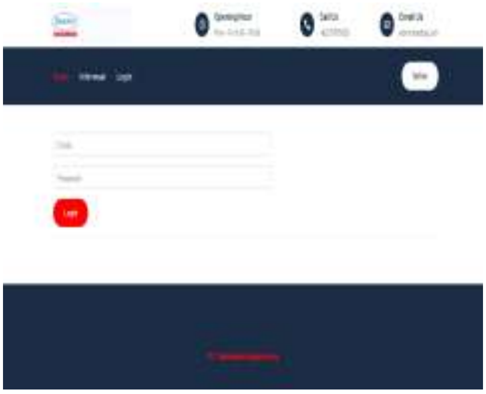

Figure 8. *Customer Login Interface*

This is what the login page looks like. Here customers can log in after completing the registration.

5. Interface customer

SITEKIN: Journal Sains Teknologi dan Industri, Vol. 20, No. 2, June 2023, pp.940 - 949
ISSN 2407-0939 print/ISSN 2721-2041 online

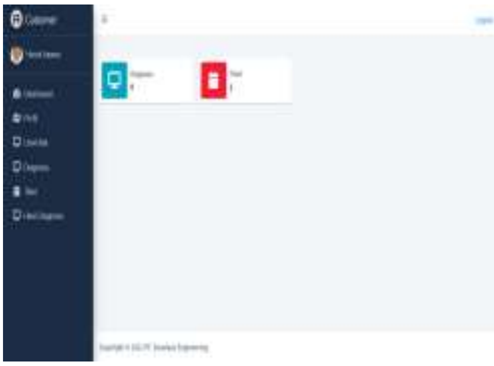

Figure 9. Customer Dashboard Interface

This a customer dashboard page, this page is the initial display after the user has successfully logged into the system.

6. Diagnostic interface

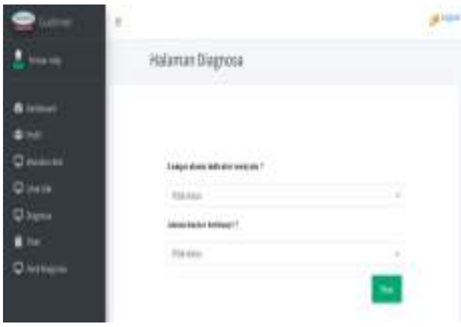

Figure 10. *Diagnostic Interface*

This a diagnosis page, customers can diagnose by answering the questions provided.

7. Login Admin and Technician

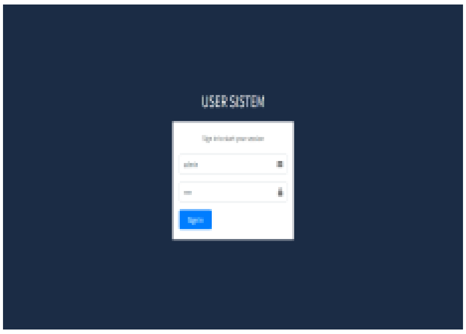

Figure 11. *Login Interface*

This a user login display, this page is a page where admins or technicians log into the system.

8. Dashboard Admin

Figure 10. *Admin Dashboard Interface*

This the admin dashboard page, this page is the initial display after the admin has successfully logged into the system.

SITEKIN: Journal Sains Teknologi dan Industri, Vol. 20, No. 2, June 2023, pp.940 - 949
ISSN 2407-0939 print/ISSN 2721-2041 online

9. Technician Dashboard

Figure 11. *Technician Dashboard Interface*

This the technician dashboard page, this page is the initial display after the technician has successfully logged into the system.

10. Entrance Ticket Interface

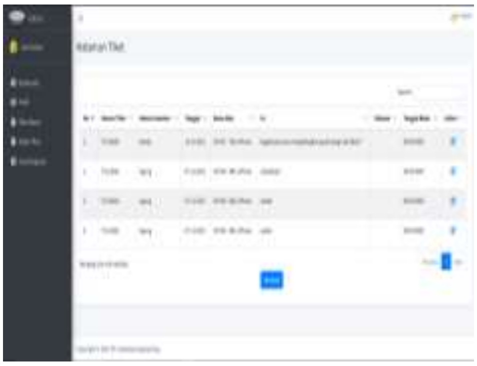

Figure 12. *Entrance Ticket Interface*

is an entrance ticket page, on this page technicians can reply to tickets sent by customers.

11. Ticket List

Figure 13. Ticket list

This a page to manage tickets, on this page technicians can manage the entire list of tickets.

12. Diagnosis results

Figure 15. Diagnosis results

is a display page of diagnostic results that have been answered by the customer.

System Testing

At this stage, researchers test the system that has been made, in this case the tester will test *the Black **Black box*** testing

According to Black Box Testing is a test method that focuses on the functional specifications of the software, testing can define a collection of input conditions and perform tests on the functional specifications of the program.(Shadiq et al., 2021)

1. *Login form* testing

Table 1. *Login Form* Testing

No	Test Scenarios	Test Case	Expected results	Conclusion
1	When the email field and password field are not filled in	Email : (empty) Password : (blank)	A *"Please fill in this field"* warning message appears.	Valid
2	When the email field is filled and the password field is left blank then click the *"Log in"* button	Email : Firmanroby07@gmail.com Password : (blank)	A *"Please fill in this field"* warning message appears.	Valid
3	When the email field is left blank and the password field is filled in then click the *"Log in"* button	Email : (blank) Password : 123456	"*Please fill in this field"* warning message appears	Valid
4	When the email is filled in incorrectly and the password is filled in incorrectly then click the button *"Log in"*	Email : emailsalah@gmail.com Password : 111222	A warning message *appears* "*You have not registered with our system"*	Valid
5	When the email and password are filled in correctly then click the *"Log in"* button	Email : Firmanroby07@gmail.com Password : 123456	A *"Congratulations You Successfully Logged In"* message appears.	Valid

2. Testing the list form

Table 2. Testing the Listing *Form*

No	Test Scenarios	Test Case	Expected results	Conclusion
1	When the field is not filled then click the "Register" button	Name : (blank) Email : (blank) Password : (blank) Phone : (blank)	"*Please fill in this field"* warning message appears	Valid
2	When the Email is registered then click the "*Register"* button	Name : firman roby Email : firmanroby07@gmail.com Password : 123456 Phone : 089509966201	An *"Email Already exists!"* warning message appears.	Valid

2	When all fields are filled then click the "*Register"* button	Name : roby firman Email : firmanroby007@gmail.com Password : 123456 Phone : 0895324569	"*Register successful"* notification message appears	Valid

3. Diagnostic Form Testing

Table 3. Diagnostic *Form* Testing

No	Test Scenarios	Test Case	Expected results	Conclusion
1	When the question field is not answered then click the "*Next"* button	The indicator light is on ? (empty) DC voltage to ground is not balanced between voltages (-)(+) ? (empty) The buzzer alarm sounded ? (empty)	A *warning message appears* "*indicator field is red".*	Valid
2	When all fields are filled in and click the "*register"* button	The indicator light is on ? (Already) DC voltage to ground is not balanced between voltages (-)(+) ? (Already) The buzzer alarm sounded ? (Already)	Go to the diagnosis page to see the diagnosis results	Valid

Conclusion

Based on the results of research that has been conducted and explained in the previous chapter, there are several problems in delivering information about damage to the charger rectifier panel which can be concluded The main purpose of designing expert system applications is to replace consultation with manual methods to be automated. This expert system application is designed to provide solutions or suggestions based on expert knowledge and experience integrated in the system, so that users can get accurate and fast answers without having to manually consult experts. Thus, expert system applications can help save time, cost, and human resources in complex consulting processes. Expert systems can help by providing a fault diagnosis on the charger's rectifier panel. This can be done with the diagnosis inquiry form so as to provide clear information and guidance regarding signs or symptoms that indicate damage to the charger rectifier panel, as well as corrective steps that can be taken by the customer. By providing proper and effective assistance, customers can save time and money needed to repair damage to the charger's rectifier panel and can ensure that the device can function properly and last longer. This expert system application is designed to provide solutions or suggestions based on expert knowledge and experience integrated in the system. With the open ticket so that technicians can quickly and precisely determine the cause of damage to the charger rectifier panel and provide appropriate repair solutions. Thus, expert system applications can help save time and costs needed to deal with damage to the charger rectifier panel, as well as improve the efficiency and quality of service provided by technicians to customers.

References

[1] N. Farzaneh, “A hierarchical expert-guided machine learning framework for clinical decision support systems: an application to traumatic brain injury prognostication,” *npj Digit. Med.*, vol. 4, no. 1, 2021, doi: 10.1038/s41746-021-00445-0.

[2] Y. Tian, “ZSLF: A New Soft Likelihood Function Based on Z-Numbers and Its Application in Expert Decision System,” *IEEE Trans. Fuzzy Syst.*, vol. 29, no. 8, pp. 2283–2295, 2021, doi: 10.1109/TFUZZ.2020.2997328.

[3] D. Lin, “Application of Comprehensive Artificial intelligence Retinal Expert (CARE) system: a

national real-world evidence study," *Lancet Digit. Heal.*, vol. 3, no. 8, 2021, doi: 10.1016/S2589-7500(21)00086-8.

[4] A. Saibene, "Expert systems: Definitions, advantages and issues in medical field applications," *Expert Systems with Applications*, vol. 177. 2021. doi: 10.1016/j.eswa.2021.114900.

[5] A. Mottahedi, "Resilience estimation of critical infrastructure systems: Application of expert judgment," *Reliab. Eng. Syst. Saf.*, vol. 215, 2021, doi: 10.1016/j.ress.2021.107849.

[6] A. K. Kirgizov, "Expert system application for reactive power compensation in isolated electric power systems," *Int. J. Electr. Comput. Eng.*, vol. 11, no. 5, pp. 3682–3691, 2021, doi: 10.11591/ijece.v11i5.pp3682-3691.

[7] M. Azarafza, "Application of fuzzy expert decision-making system for rock slope block-toppling modeling and assessment: a case study," *Model. Earth Syst. Environ.*, vol. 7, no. 1, pp. 159–168, 2021, doi: 10.1007/s40808-020-00877-9.

[8] A. Sarazin, "Expert system dedicated to condition-based maintenance based on a knowledge graph approach: Application to an aeronautic system," *Expert Syst. Appl.*, vol. 186, 2021, doi: 10.1016/j.eswa.2021.115767.

[9] M. Sridharan, "Application of fuzzy logic expert system in predicting cold and hot fluid outlet temperature of counter-flow double-pipe heat exchanger," *Advanced Analytic and Control Techniques for Thermal Systems with Heat Exchangers*. pp. 307–323, 2020. doi: 10.1016/B978-0-12-819422-5.00014-1.

[10] W. A. Abbasi, "COVIDC: An expert system to diagnose COVID-19 and predict its severity using chest CT scans: Application in radiology," *Informatics Med. Unlocked*, vol. 23, 2021, doi: 10.1016/j.imu.2021.100540.

[11] M. Sridharan, "Short review on various applications of fuzzy logic-based expert systems in the field of solar energy," *International Journal of Ambient Energy*, vol. 43, no. 1. pp. 5112–5128, 2022. doi: 10.1080/01430750.2021.1927839.

[12] A. Heiß, "Modeling and simulation of a multi-parametric fuzzy expert system for variable rate nitrogen application," *Comput. Electron. Agric.*, vol. 182, 2021, doi: 10.1016/j.compag.2021.106008.

[13] H. Salem, "A systematic review of the applications of Expert Systems (ES) and machine learning (ML) in clinical urology," *BMC Med. Inform. Decis. Mak.*, vol. 21, no. 1, 2021, doi: 10.1186/s12911-021-01585-9.

[14] L. Li, "Expert consensus on the application of artificial liver blood purification system in the treatment of severe and critical COVID-19," *Chinese J. Clin. Infect. Dis.*, vol. 13, no. 1, pp. 1–3, 2020, doi: 10.3760/cma.j.issn.1674-2397.2020.01.001.

[15] Z. Gang, "Expert consensus on clinical application of metagenomic next-generation sequencing of cerebrospinal fluid in the diagnosis of infectious diseases of the central nervous system," *Chinese J. Neurol.*, vol. 54, no. 12, pp. 1234–1240, 2021, doi: 10.3760/cma.j.cn113694-20210730-00532.

[16] H. K. Mamidi, "Application of modified SeDeM expert diagram system for selection of direct compression excipient for liquisolid formulation of Neusilin® US2," *J. Drug Deliv. Sci. Technol.*, vol. 64, 2021, doi: 10.1016/j.jddst.2021.102506.

[17] B. Chudasama, "Target-scale prospectivity modeling for gold mineralization within the Rajapalot Au-Co project area in northern Fennoscandian Shield, Finland. Part 1: Application of knowledge-driven- and machine learning-based-hybrid- expert systems for exploration targeting and addressing model-based uncertainties," *Ore Geol. Rev.*, vol. 147, 2022, doi: 10.1016/j.oregeorev.2022.104937.

[18] A. Musaev, "MULTI-EXPERT SYSTEMS: FUNDAMENTAL CONCEPTS AND APPLICATION EXAMPLES," *J. Theor. Appl. Inf. Technol.*, vol. 100, no. 2, pp. 336–348, 2022, [Online]. Available: https://api.elsevier.com/content/abstract/scopus_id/85124474678

[19] O. Varlamov, "'Brains' for Robots: Application of the Mivar Expert Systems for Implementation of Autonomous Intelligent Robots," *Big Data Res.*, vol. 25, 2021, doi: 10.1016/j.bdr.2021.100241.

[20] S. Srivastava, "Application of an expert system of X- ray micro computed tomography imaging for identification of Sitophilus oryzae infestation in stored rice grains," *Pest Manag. Sci.*, vol. 76, no. 3, pp. 952–960, 2020, doi: 10.1002/ps.5603.

[21] M. Tavana, "A practical review and taxonomy of fuzzy expert systems: methods and applications," *Benchmarking*, vol. 27, no. 1. pp. 81–136, 2020. doi: 10.1108/BIJ-04-2019-0178.

[22] J. Rodger, "An expert system gap analysis and empirical triangulation of individual differences, interventions, and information technology applications in alertness of railroad workers," *Expert Syst. Appl.*, vol. 144, 2020, doi: 10.1016/j.eswa.2019.113081.