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Research Article

The Design Of An Android-Based Lung Disease Screening Expert System And Patient Early Warning Using The Forward Chaining Method At Waluyo Jati, Kraksaan Hospital

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ABSTRACT

This aims of study were design and create an android-based lung disease screening expert system and patient early warning using the forward chaining method at Waluyo Jati Kraksaan Hospital. This study used a mixed methods approach, namely descriptive qualitative and quantitative descriptive. In this descriptive qualitative research design used case study and the quantitative descriptive research design uses a survey. This research used the forward chaining method and model development using the Waterfall model. Based on the accuracy test table, it can be concluded that the Android-based lung disease diagnosis expert system uses the Forward chaining method. The ISO/IEC 9126 standard test uses two aspects, namely the usability aspect of 83.45% and the Functionality aspect of 85.1%. The certainly factor for the confidence value can be identified quite well. This is evidenced by the results of testing the system accuracy of 96.43%. An Android-based lung diagnostic expert system was built to provide identification conclusions in accordance with the thoughts of an expert, namely a lung specialist.

Keywords: *Android, expert, lung disease, screening and system*

INTRODUCTION

Lung disease is a disease which is quite serious. Improper handling and treatment of lung disease will be fatal and even cause the risk of death. According to WHO in 2017-2020 the mortality rate in cases of respiratory system disease (respiratory) in Indonesia was ranked 5th, namely ±96,316 people and Tuberculosis (TB) was ranked 6th, which was ±82,219 people. Lung disease is a disease related to the respiratory system (Gustinaldi, 2019). This disease has several types and classifications are quite varied. The lung diseases in this study were pulmonary tuberculosis (TB), Covid-19 (Corona Virus 19), upper respiratory tract infections (ARI), pneumonia, and chronic obstructive pulmonary disease (COPD).

At this time, science and technology has experienced rapid improvement and progress in various fields. Especially in the health sector, namely medical science and technology, has reached a satisfactory level both in terms of overcoming cases of infectious and non-communicable diseases

(Alda, 2022). One of them can be known through screening for early symptoms experienced and later it can be an early warning to take some early actions to deal with a disease (Abidin, 2016). Waluyo Jati Hospital has several screenings carried out at the pulmonary polyclinic, namely observing patients, namely asking and answering patients in the form of any complaints that are felt and experienced, physical examination in the form of blood pressure, respiratory tract and body temperature. In addition, the hospital also conducted screening in the form of x-rays (Cahyadi, 2018). The following are the results of data on new cases of lung disease at Waluyo Jati Hospital in the last 5 years (2017-2021), namely 620 Covid-1 patients, 714 COPD patients, 2,632 ARI, 2,822 pulmonary TB patients, and 3,943 pneumonia patients. As for the results of the number of deaths from lung disease in the last 5 years (2017-2021), namely ARI 0 patients, COPD 18 patients, pulmonary TB 126 patients, Covid-19 302 patients and pneumonia 336 patients.

There are problems that occur in hospital services, especially patients and doctors. Physician crisis in primary care (puskesmas, clinics, and the like). Many primary health services do not have doctors and many areas do not have health services or are far from health services. The Capability problem is an obstacle in which there may indeed be a lot of general practitioners, but not specialist doctors. Meanwhile, regarding Capacity, medical devices with innovative breakthroughs that are not yet owned by many hospitals. Even if there is, the availability is limited so that it is unable to accommodate the large number of patients. In addition, there are problems with online services that are still hampered by adequate technology. Whereas in online services there are many obstacles in the registration process, service performance and the use of technology that is still not updated.

This android application is designed to help patients or users experience problems at distance, where the distance from the house is very far from the hospital, reducing costs because it will require large costs to be prepared when going to the hospital, and this application is mobile that can done wherever and whenever needed (Levina and Birowo, 2020). So that the public can access information related to lung disease by screening for the initial symptoms experienced. And can find out the disease and the appropriate initial action for the treatment of lung disease (Irwandy, 2019).

Based on the above background, the application of the expert system application design is expected to be able to solve the problem of low public knowledge and information about the symptoms of lung disease. And can improve health information systems in the field of android. In making this expert system using the forward chaining method. Forward chaining is forward tracking and uses IF-THEN rules. starting from the process of searching for a set of data or facts, from the facts to find a conclusion that becomes a solution. The method was chosen because this method is easy to apply to diagnose types of lung disease from the symptoms that arise based on data validation from experts (Fahmy et al., 2018).

The aims of study were to design and create an Android-based expert system for lung disease screening and early warning patients using the forward chaining method at Waluyo Jati Kraksaan Hospital. drug taking alarm and ICD 10 code from android-based lung disease diagnosis. This expert system has 2 access rights, namely first, the user to access the android application. Second, doctors to update data by adding or reducing symptoms or diseases on the admin page according to developing science. The purpose of this study was to design and create an Android-based expert system for lung disease screening and early warning patients using the forward chaining method at Waluyo Jati Kraksaan Hospital. Doctors to update data by adding or reducing symptoms or diseases on the admin page according to developing science. The purpose of this study was to design and create an Android-based expert system for lung disease screening and early warning patients using the forward chaining method at Waluyo Jati Kraksaan Hospital. Doctors to update data by adding

or reducing symptoms or diseases on the admin page according to developing science. The purpose of this study was to design and create an Android-based expert system for lung disease screening and early warning patients using the forward chaining method at Waluyo Jati Kraksaan Hospital.

METHOD OF THE STUDY

This study used a mixed methods approach, namely descriptive qualitative and quantitative descriptive. In this descriptive qualitative research design using a case study using a survey. This approach was a type of exploratory sequential design. This study also uses the forward chaining method and model development using Waterfall. The research location was RSUD Waluyo Jati Kraksaan which is located in Probolinggo Regency, East Java Province. The time of the research was carried out sixteen months. January 2021 to April 2022. The population in this study was polypulmonary patients at Waluyo Jati Kraksaan Hospital during the period January 2021 to May 2021. While the minimum number of samples to test the functionality and usability of the system is at least 20 people.

Research variables include functionality to test the function/usability of the system and usability to test the ease of using the system. Data collection techniques are questionnaires to test information systems based on functionality and usability aspects. Research approach with quantitative questionnaires to test information systems based on functionality and usability aspects. The data analysis technique used descriptive statistics. Then the data analysis of usability aspects, functionality aspects and usability aspects (Rahim et al., 2018).

In the system menu features, namely pulmonary consultation (answer questions), disease information, reminder alarms (alarm taking medicine and taking medicine), disease charts as well as about. The final result of this expert system is in the form of an explanation of the disease, the source of transmission, methods of prevention, action, alarm taking medicine, alarm taking medicine and ICD 10 code from android-based lung disease diagnosis. This expert system has 2 access rights, namely first, the user to access the android application. Second, doctors to update data by adding or reducing symptoms or diseases on the admin page according to developing science (Pratiwi, 2019). The purpose of this study was to design and create an Android-based expert system for lung disease screening and early warning patients using the forward chaining method at Waluyo Jati Kraksaan Hospital. Drug taking alarm and ICD 10 code from android-based lung disease diagnosis. This expert system has 2 access rights, namely first, the user to access the android application. Second, doctors to update data by adding or reducing symptoms or diseases on the admin page according to developing science.

RESULTS AND DISCUSSION

Lung Disease Diagnosis Expert System With Certainty Factor Method

The result of making concepts between Knowledge engineers and experts is the collection of data regarding information about lung disease. Based on the analysis obtained, lung disease is divided into 5 diseases, namely:

1. Lung Disease Analysis

Table 1. Analysis of Pulmonary TB Disease

No	Disease Data	Symptom Data	Action	Code ICD 10

1	Pulmonary Tuberculosis (pulmonary TB)	Cough for more than 4 weeks, chest pain, coughing up blood, fever, weight loss, malaise (fatigue), and night sweats without physical activity.	Laboratory examination for sputum examination, routine blood examination, Microscopic Sputum Examination (Montoux test), chest X-ray, Bacteriological Examination (Direct Smear) and Administration of Anti Tuberculosis Drugs (OAT), namely Isoniacid (H); Rifampicin (R); Pyrazinamide (Z); Ethambutol (E); and Streptomycin (S). Treatment is routine for 6-8 months. And treatment is given according to the patient's weight.	**A15.0**

Pulmonary TB test data are described below.

Table 2. Outpatient Data for the Period 2017-2022

Year	LUNG TB			
	Number Of New Cases		Number of New Cases	Number of Visits
	Man-Man	*Woman*		
2017	845	627	1472	329
2018	195	174	369	1875
2019	326	276	602	1457
2020	29	26	55	877
2021	173	151	324	869
2022 (January - March)	35	30	65	207

Outpatient data for pulmonary TB in 2017-2022, the highest number in 2017 was the number of new cases as many as 1472 patients and the number of visits as many as 329 patients. With the characteristics of male sex as many as 845 and 627 women.

Table 3. Hospitalization Data for the Period 2017-2022

Year	LUNG TB			
	Number of New Cases		Number of Patients out Life	Number of Patients out
	Man-Man	Woman		
2017	67	53	105	15
2018	96	73	136	33
2019	170	111	241	40
2020	85	57	125	17
2021	159	96	234	21
2022 (January - March)	39	31	62	8

Pulmonary TB inpatient data in 2017-2022, the highest number in 2019 was the number of patients discharged alive as many as 241 patients and the number of patients discharged dead as many as 40 patients. With the characteristics of male sex as many as 170 and 111 women.

2. COVID-19 (Corona Virus Disease 19)

Table 4. Analysis of Covid-19 Disease

No	Disease Data	Symptom Data	Action	ICD code 10

1.	Corona Virus Disease 19 (COVID19)	Cough, shortness of breath, abdominal pain, nausea, vomiting, diarrhea, anosmia (loss of sense of smell), and ageusia (loss of sense of taste).	Performed by examination of rapid antibodies, rapid antigen, and PCR Swab, perform routine checks of body temperature (<37.50C), perform chest X-Ray, CT Scan of the chest, and ultrasound of the lungs. After that, self-isolate at home for 10 days from the time the confirmation diagnosis specimen is taken, both at home and in public facilities prepared by the government. After that, the patient is monitored by telephone by First Level Health and Facilities (FKTP) officers, Control at the nearest FKTP after 10 days of quarantine for clinical monitoring.	B34.9

Covid-19 Test a included:

Table 5. Outpatient Data for the Period 2017-2022

Covid-19				
Year	Number of New Cases		Amount new Case	Number Of Visits
	Man	Woman		
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	30	32	62	559
2021	176	249	425	47
2022 (January - March)	60	73	133	92

Outpatient data for Covid-19 in 2017-2022, the highest number in 2020 for the number of visits as many as 559 patients. And the highest number in 2021 for the number of new cases as many as 425 patients. and the number with male sex characteristics is 176 and female is 249.

Table 6. Hospitalization Data for the Period 2017-2022

Covid-19				
Year	Number of New Cases		Number of Patientsout of Life	Number of Patientsout off
	Man	Woman		
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	240	260	426	74
2021	313	428	513	228
2022 (January - March)	58	78	120	16

Data for hospitalization for Covid-19 in 2017-2022, the highest number in 2021, namely the number of patients who were discharged alive as many as 513 patients and the number of patients who were discharged and died as many as 228 patients. With the characteristics of male sex as many as 170 and 111 women.

3. ARI (*Upper Respiratory Tract Infection*)

Table 7. Analysis of ARI Disease

No	Disease Data	Symptom Data	Action	ICD code 10
1.	ARI (Upper Respiratory Tract Infection)	Cough, shortness of breath, itchy throat, painful swallowing. Fever, sneezing, runny nose, headache, body aches (myalgia).	Actions and treatment in ARI are giving antibiotics, giving intravenous fluids when signs of dehydration appear, mucus or fluid that clogs the nose or airway is sucked in with a mucus suction device, using steam to widen the airway, giving oxygen.	**J06.9**

ARI Test Data as follows.

Table 8. Outpatient Data for the Period 2017-2022

ARI				
Year	Number of New Cases		Amount new Case	Number of Visits
	man	Woman		
2017	768	1021	1789	358
2018	124	128	252	1923
2019	63	99	162	490
2020	159	209	368	1454
2021	27	34	61	679
2022 (January - March)	20	7	27	37

Outpatient data for ARI in 2017-2022, the highest number in 2017 was the number of new cases as many as 1789 patients and the number of visits as many as 358 patients. With the characteristics of male sex as many as 768 and 1021 women.

Table 9. Hospitalization Data for the Period 2017-2022

Year	Number of new cases		Number of patients come out alive	Number of patients discharged
	Man	Woman		
2017	16	27	43	0
2018	49	41	90	0
2019	15	12	27	0
2020	25	27	52	0
2021	26	24	50	0
2022 (January - March)	18	6	24	0

Data for hospitalization for ARI in 2017-2022, the highest number in 2018 was in the number of patients discharged alive as many as 90 patients. With the characteristics of male gender as many as 49 and 41 female.

4. Pneumonia

While the analysis of pneumonia

Table 10. Analysis of Pneumonia

Disease Data	Symptom Data	Action	ICD code 10

1.	Pneumonia	Cough, fever, fast heart rate, chills, cough with phlegm, shortness of breath, sharp pain in the chest	Supportive treatment such as bed rest and drinking enough to treat dehydration, definitive therapy can be done using antibiotics (Penicillin sensitive Streptococcus pneumoniae (PSSP), penicillin-resistant Streptococcus pneumonia (PRSP)), and perform further investigations if necessary: PA chest X-ray, sputum examination, routine blood collection, sputum culture and blood culture.	**J18.9**

Pneumonia test data, namely:

Table 11. Outpatient Data for the Period 2017-2022

PNEUMONIA				
Year	Number of New Cases		Number of New Cases	Number of Visits
	Man	Woman		
2017	1384	1334	2718	1155
2018	574	423	997	2609
2019	21	8	29	46
2020	70	66	136	1953
2021	35	28	63	67
2022 (January - March)	142	113	255	117

Pneumonia outpatient data in 2017-2022, the highest number in 2017 was the number of new cases as many as 2718 patients and the number of visits as many as 1155 patients. With 1384 male and 1334 female characteristics.

Table 12. Inpatient Data for the Period 2017-2022

Pneumonia				
Year	Number of New Cases		Number of Patients Exit Alive	Number of Patients Out Dead
	Man	Woman		
2017	418	305	680	43
2018	373	270	589	54
2019	333	265	598	58
2020	448	391	721	118
2021	606	635	1178	63
2022 (January - March)	124	91	206	9

Inpatient data for pneumonia in 2017-2022, the highest number in 2021 is the number of patients discharged alive as many as 1178 patients and the number of patients discharged dead as many as 63 patients. With sex characteristics of 606 males and 635 females.

5. COPD (Chronic Obstructive Pulmonary Disease)

Table 13. Analysis of COPD

No	Data Disease	Symptom Data	Action	ICD code 10

1.	COPD	Cough, fever, weak breath sounds, shortness of breath, shortness of breath, wheezing, malaise (fatigue), weight loss, swelling in the legs and feet, sharp pain in the chest. Dazed and hard to concentrate	Consult a doctor and perform blood tests, pulmonary function tests, x-rays and CT scans of the lungs, perform oxygen therapy,spirometry, and bronchodilator testing,	**J44.9**

COPD test data were:

Table 14. Outpatient Data for the Period 2017-2022

COPD				
Year	Number Of New Cases		Number Of New Cases	Number Of Visits
	Man	Woman		
2017	215	68	283	2027
2018	175	71	246	1665
2019	35	41	76	135
2020	50	32	82	681
2021	8	9	17	113
2022 (January - March)	10	0	10	36

Outpatient data for COPD in 2017-2022, the highest number in 2017 was the number of new cases as many as 283 patients and the number of visits as many as 2027 patients. With 215 male and 68 female characteristics.

Table 15. Inpatient Data for the Period 2017-2022

COPD				
Year	Number Of New Cases		Number Of Patients out Of Life	Number Of Patients Out Of Dead
	Man	Woman		
2017	74	56	129	1
2018	113	149	260	2
2019	200	87	278	9
2020	77	35	110	2
2021	32	9	37	4
2022 (January - March)	9	5	14	0

Data on COPD inpatients in 2017-2022, the highest number in 2019 was in the number of patients who were discharged alive as many as 278 patients and the number of patients who were discharged died as many as 9 patients. With 200 male and 87 female characteristics.

Disease diagnosis results were:

1. Pulmonary Tuberculosis Disease
   The calculation of pulmonary TB disease was tested into the system, and the system gave the same output of 98.25%. So it can be concluded that the calculation of Certainty Factor carried out by the system is correct.
2. Covid 19 Disease Diagnosis Results
   The calculation of the Covid-19 disease is tested into the system, and the systemgives the same output that is 98.92%. So it can be concluded that the calculation of Certainty Factor carried out by the system is correct.
3. ARI diagnosis results
   This ARI calculation was tested into the system, and the system gave the same output of

98.73%. So it can be concluded that the calculation of Certainty Factor carried out by the system is correct.

4. Pneumonia Diagnosis Results

   The calculation of this pneumonia disease was tested into the system, and the system gave the same output of 98. 88%. So it can be concluded that the calculation of Certainty Factor carried out by the system is correct.

5. COPD Diagnosis Results

   The COPD calculation was tested into the system, and the system gave the same output of 98.21%. So it can be concluded that the calculation of Certainty Factor carried out by the system is correct.

Waterfall Model

1. Requirements analysis and Definition

   Needs analysis to support system requirements. collect the necessary data in full, including: symptom data and disease data. and determination of system access rights. Then the data will be applied.

2. System and Software Design

   In this stage, the design of the program to be made includes the manufacture of document flowcharts, Use case diagrams, Class Diagrams, and Activity Diagrams.

3. Implementation and unit testing

   At this stage, the programming and implementation of the system design is made into the html programming language and for database creation using the Macromedia Dreamweaver 8.0 application along with MySQL as the database (Sahrial et al., 2022). Here will also be carried out functional unit testing and error handling in the program. At first, the user logs in and the initial form will appear, then the user selects the consultation menu, then the user will be given several kinds of symptoms to check, and the system will provide a result page regarding explanation, source of transmission, prevention, action, and disease coding (Setyaputri et al., 2018). Users can also create an alarm reminder to take medication.

4. Integration and system testing

   After the decision support system is completed, the next stage is the stage of integrating the program parts into a single unit and testing the system. This test is also carried out functionally and error handling on the system using black-box.

5. Operation and Maintenance

   Operate the program in its environment and perform maintenance, such as adjustments and changes as it adapts to the situation. In this Final Project, Operation and Maintenance activities are not carried out.

Based on the results of the Focus Group Discussion (FGD) that was carried out at Waluyo Jati Hospital, the hospital agreed with the android expert system. In the design and manufacture of an Android-based expert system, it is hoped that later it will be able to overcome the problems found at this time. This system has features that can help android visitors to get more complete and useful information and services such as consulting features and dynamic systems (data changes) (Tristianto, 2018).

System and Software Design

In making the design of this Android-based pulmonary disease expert system program, there are several stages that must be carried out, namely: Making Document Flowcharts, Use Case Diagrams, Class Diagrams and Activity Diagrams (Utami et al., 2016).

1. Document Flowchart

   Flowcharts are used to analyze, design, document or manage a process or program in various fields. Users can start operating the application by logging in. then choose what menu you want to choose, if you choose a consultation by answering questions about some symptoms correctly. If the results are correct then the results of the disease diagnosis of lung disease will appear. However, if it is wrong then the disease result will not appear and there will be a notification "sorry the symptoms you selected do not include indications of lung disease". Users can also select other menus such as disease information, disease graphs and alarms for taking medication and taking medication. And then a notification will appear according to the selected menu.

2. Use Case Diagrams

   This diagram illustrates a relationship between Actor (Admin and User) integrated with the system. In this diagram there are 2 actors. Namely admin and user. Each actor has different access to the integration of the system. First, admins can integrate on the admin panel menu (edit rule data, edit disease data and edit user data) where admins can add or remove data on the system. Then you can also access the integration on other menus, for example (pulmonary consultation, disease information, reminder alarms, disease charts and about). Second, users only have access to integration in the application menu, namely (pulmonary consultation, disease information, reminder alarms, disease graphs and about).

c. Class Diagram

   Class diagrams is a diagram that describes the classes in the system and their logical relationships. The class diagram created at this design stage is a complete description of the classes handled by the system, where each class has been equipped with the required attributes and operations (Wijaya and Tanamal, 2019). This application has five classes where all classes are related to each other, the admin class creates an authority that can access the login class so that the user can access the disease class, symptom class and rule class. The login class is also useful for filtering application users who have access rights and do not have access and can even avoid attacks on applications

d. Activity Diagrams

   Describing the flow of activity of the system being designed. How the system starts and ends.

Results of Percentage Calculation of Certainty Factor (CF) Values in each disease

The results of the Percentage Calculation of Certainty Factor (CF) values for each disease explained that the calculation of pulmonary TB was tested into the system, and the system gave the same output, namely 98.25%. So it can be concluded that the calculation of Certainty Factor carried out by the system is correct. The calculation of the Covid-19 disease was tested into the system, and the system gave the same output of 98.92%. So it can be concluded that the calculation of Certainty Factor carried out by the system is correct.

This ARI calculation was tested into the system, and the system gave the same output of 98.73%. So it can be concluded that the calculation of Certainty Factor carried out by the system is correct. The calculation of this pneumonia disease was tested into the system, and the system gave

the same output of 95.57%. So it can be concluded that the Certainty Factor calculation carried out by the system is correct.

The COPD calculation was tested into the system, and the system gave the same output of 97.07%. So it can be concluded that the Certainty Factor calculation carried out by the system is correct.

CONCLUSION AND SUGGESTION

Based on the design, implementation and testing of an Android-based expert system for diagnosing lung disease. Then it can be concluded that on the accuracy test table, it can be concluded that the Android-based expert system for diagnosing lung disease uses the Forward chaining method. And the ISO/IEC 9126 standard test uses two aspects, namely the usability aspect of 83.45% and the Functionality aspect of 85.71%. The certainly factor for the confidence value can be identified quite well. This is evidenced by the results of testing the system accuracy of 96.43%. An Android-based lung diagnostic expert system was built to provide identification conclusions according to the thoughts of an expert, namely a pulmonary specialist

Based on the research, there are several things that can be suggested, namely 1) this android-based expert system can be developed and processed for diseases other than lung disease. For example, heart disease, internal disease, bone disease and so on, 2) Expected to provide solutions and benefits as a medium of information and a companion system for diagnosing types of lung disease through screening for early symptoms; 3) The application of this developed lung diagnosis expert system can be developed using other methods that may affect it such as backward chaining, depth first search, breadth first search, AHP (analytical Hierarchy Process) and 4) the development of expert system models are expected to use other models that may be designed such as ESDLC (Expert System Development Life Cycle) and 6) For lung disease patients, routine visits should be carried out to always control their health. This maximizes routine and timely control schedules.

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