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DIAGNOSING ANDROID-BASED VIRUS INFECTIONS IN CHILDREN USING NAIVE BAYES

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Abstract: Infectious diseases are one of the most common health problems in children because they have immature immune systems. Children are more susceptible to infections caused by bacteria, viruses, fungi, and protozoa. Some common infectious diseases in children include fever, acute respiratory infections (ARI), pneumonia, acute gastroenteritis (GAE), measles, chickenpox, and diphtheria. The limited number of pediatricians and the difficulty of accessing health facilities in remote areas hinder children's health services. To overcome this, an Android-based expert system is needed using the Naïve Bayes method to help diagnose infectious diseases in children earlier. The research method used is the Software Development Life Cycle (SDLC), where Black Box is used for internal testing, and PSSUQ is used to measure user satisfaction. The data set used was 1320 taken from a local hospital. The test results show that all the main features work as expected without any errors. The implementation of the system in diagnosing diseases went well and based on end-user feedback from 74 respondents, the system obtained a user satisfaction score of 6.40, where users felt that the system was easy to use, efficient, and provided clear and useful information.

Keywords: expert system; infectious disease; naïve bayes; PSSUQ; SDLC

Abstrak: Penyakit menular merupakan salah satu masalah kesehatan yang paling umum terjadi pada anak-anak karena mereka memiliki sistem kekebalan tubuh yang belum matang. Anak-anak lebih rentan terhadap infeksi yang disebabkan oleh bakteri, virus, jamur, dan protozoa. Beberapa penyakit infeksi yang umum terjadi pada anak-anak antara lain demam, infeksi saluran pernapasan akut (ISPA), pneumonia, gastroenteritis akut (GEA), campak, cacar air, dan difteri. Keterbatasan jumlah dokter spesialis anak dan sulitnya akses ke fasilitas kesehatan di daerah terpencil, menjadi kendala pada pelayanan kesehatan anak. Untuk mengatasi hal tersebut, diperlukan sistem pakar berbasis Android menggunakan metode Naïve Bayes untuk membantu mendiagnosis penyakit infeksi pada anak-anak lebih dini. Metode penelitian yang digunakan adalah Software Development Life Cycle (SDLC), di mana Black Box untuk pengujian internal, dan PSSUQ untuk mengukur kepuasan pengguna. Data set yang digunakan adalah 1320 yang diambil dari rumah sakit setempat. Hasil pengujian menunjukkan bahwa seluruh fitur utama berjalan sesuai harapan tanpa kesalahan. Implementasi sistem dalam mendiagnosa penyakit berjalan dengan baik dan berdasarkan umpan balik pengguna akhir dari 74 responden, sistem memperoleh skor kepuasan pengguna sebesar 6,40, di mana pengguna merasa sistem ini mudah digunakan, efisien, serta menyediakan informasi yang jelas dan bermanfaat.

Kata kunci: naïve bayes; penyakit menular; PSSUQ; SDLC; sistem pakar

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INTRODUCTION

Infectious diseases are among the most common health problems, especially in children [1]. Communicable diseases are caused by the entry of microorganisms such as bacteria, viruses, fungi, prions, and protozoa into the body. These microorganisms then multiply and cause damage to human organs [2]. The human immune system, especially in children whose immune systems are not yet fully mature, makes them more susceptible to infectious diseases [3]. Some common infectious diseases suffered by children include fever [4], upper respiratory tract infections (URTIs) [5], pneumonia [6], acute gastroenteritis (GEA), diarrhea [4], measles [7], chickenpox [8], to serious conditions such as diphtheria and febrile seizures [1]. These conditions often require rapid and accurate diagnosis and treatment, so the role of pediatricians is very important in handling these diseases [9].

However, there are several significant obstacles to children's health services [10]. Hospitals usually only have one pediatrician who is tasked with handling various cases of fairly complex childhood diseases [11]. The limited number of doctors has an impact on the length of patient queues so the process of diagnosis and medical treatment is often delayed [12].

In addition to the small number of pediatricians, a large number of patients come from remote areas with difficult access to hospitals, so they need a lot of time and money to get treatment [13]. This problem is further exacerbated by the high workload of existing medical personnel, thus affecting the overall quality of health services [14]. In a situation like this, an innovative solution is needed that can help ease the burden on medical personnel and speed up the disease diagnosis process.

In an era of increasingly advanced technology, the use of expert systems is a relevant solution to answer these problems. [15]. An expert system is a computer program designed to imitate the abilities of an expert in a particular field [16]. Expert systems are designed to provide solutions based on the knowledge and experience of an expert. [17]. Expert systems in the health sector are used to diagnose various types of diseases based on selected symptoms. [18]. Mobile-based system implementations are becoming increasingly popular due to their portable, accessible, and efficient nature [19]. Mobile-based systems make it easier for users to access and obtain health information anytime and anywhere, without meeting directly with medical personnel.

One of the algorithms often used in expert systems is the Naive Bayes method. This method is a probability-based classification algorithm based on Bayes' Theorem with the assumption of independence between features. [20]. In the case of disease diagnosis, this method calculates the probability of a disease based on the symptoms shown by the patient [21]. For example, if a disease is usually accompanied by symptoms A and B, then when these symptoms are found in a patient, the system will provide a probability that the patient has the disease. Although the assumption of independence between features is not always met in the application of expert systems, the Naive Bayes method has proven to be effective and is often used in various applications, including expert systems in the health sector [22].

Several previous studies have shown that expert systems can have a positive impact in helping diagnose dis-

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eases. Expert systems have a fairly accurate ability to provide diagnoses based on symptom data provided by users. [23]. Other research using the Naive Bayes method is very suitable for use in processing numerical data, especially applications that require speed and accuracy such as expert systems. [24]. Research related to the development of Android-based expert systems has proven that this approach is capable of providing information that is fast, accurate, and easily accessible to users [25].

Based on the description of the problems and the support of current technological developments, the researcher proposes the design of an Android-based expert system by applying the Naive Bayes method to diagnose viral infectious diseases in children. This system is designed to make it easier for parents to find out the type of infectious disease suffered by their children based on the symptoms given. Parents no longer need to come directly to the hospital to get initial information about their children's health conditions.

Some viral infectious diseases that often occur in children include fever, diarrhea, ARI, pneumonia, GEA, measles, chickenpox, diphtheria, diaper rash, and febrile seizures are diseases that require a fast and accurate diagnosis so that treatment can be carried out optimally. By utilizing an Android-based expert system, the diagnosis process is expected to be carried out quickly, so that it can help families who live in remote areas and have difficulty accessing health facilities.

METHOD

Many methods and techniques can be used to solve problems in research, one of which is the Software Development Live Circle (SDLC) method [26]. This method is a research method with 6 stages of completing the development system. The sixth stage owned by SDLC is planning, design, development, implementation, testing, and maintenance [27]. In the SDLC method, there are stages of the Development and Testing process. In the development process, internal system testing is carried out using Black Box. While in the testing process, the Post-Study System Usability Questionnaire (PSSUQ) technique is used for maximum testing results [28]. The PSSUQ method is a system analysis method to determine the usability, quality of information and quality of the user interface on a system. [29]. The application of the SDLC method with a combination of Black Box and PSSUQ is shown in Figure 1.

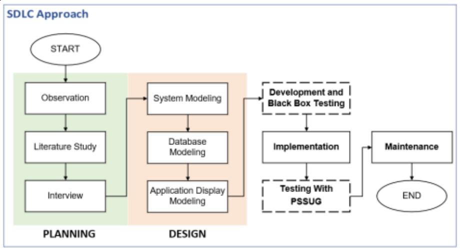

Figure 1. SDLC Approach Research Flow

Planning

At the planning stage, data and information are collected as the initial step in the research implementation process. The data and information obtained are processed to obtain the problems and system descriptions needed.

Design

At this stage, system design will be carried out in three forms, namely System Modeling, Database Modeling and Application Display Modeling.

Development and Black Box Testing

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At this stage the process of developing and integrating all assets is carried out using the selected programming language. During the development period, internal testing is carried out using Black Box Testing to ensure that all components can be used and function optimally.

Implementation

Implementation is carried out to determine the extent to which the system functions well in the field when used by end users and to collect feedback from end users for further testing processes.

Testing With PSSUQ

Testing using PSSUQ was carried out to collect feedback data from end users by distributing questionnaires to analyze usability, information quality and user interface quality.

Maintenance

The final process that needs to be done after the system is implemented is to perform maintenance to maintain the performance of the system. Improvements are made based on input from users obtained during the implementation period.

RESULT AND DISCUSSION

After going through a series of system development stages and internal testing as in Table 3, the test results show that all main features, including symptom input, classification process, and diagnosis output are running well. Every scenario given in the testing of system features can be processed well without any errors. One example of testing is carried out by selecting several types of disease symptoms as presented in Table 1. From the results of choosing several symptoms, calculations are carried out based on their respective weights and processed by the system using the Naïve Bayes algorithm to determine the level of probability value. The probability calculation is carried out based on the formula rules in the Naïve Bayes algorithm where the probability of data with attributes in the P(Y|X) class is obtained from the independent class probability of all attributes divided by the number of data from the class being asked.

When the weight value of the disease rule of Acute Gastroenteritis (GEA) has a weight of disease 0.9 as presented in Table 3. While the symptom G03 (Stomach ache) has a rule weight of 0.4, and the symptom G04 (Fever) has a rule weight of 0.2. So, the substitution of the symptom rule weight and the disease weight can be calculated by multiplying the symptom weight value of G03 (0.4) by the weight value of the Acute Gastroenteritis disease (0.9), resulting in a substance value of 0.36. To determine the substitution of the rule weight of G04 (0.2) and the weight of the Acute Gastroenteritis disease (0.9) is 0.2 x 0.9 with a result of 0.18.

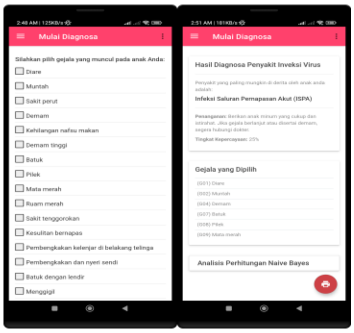

Image 2. (a) Symptom choice and (b) Example of Diagnosis Results

Table 1. Selected Symptoms

No	Code	Question
1	G03	Sakit perut
2	G04	Demam
3	G07	Batuk
4	G26	Mual

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Table 2. Black Box Testing Example

Tested Cases	Functions	Expected	Results
Diagnostic Process Button	Selecting the diagnostic process button	Successfully displaying the results of the Naïve Bayes method calculation in diagnosing viral infectious diseases in children.	Success
Print Button	Selecting the Print button	Successfully saving the diagnosis results into PDF format	Success

Table 3. Naïve Bayes Calculation Analysis Axample

Disease	Disease Weight (P)	Symptom Code	Sysmptom Weight (G)	Multiply P x G	Probabilitas
Gastroenteritis Akut (GEA)	0.9	G03	0.4	0.36	0.324
Gastroenteritis Akut (GEA)	0.9	G04	0.2	0.18	0.162
Campak (Morbili)	0.8	G07	0.5	0.4	0.32
Infeksi Saluran Pernapasan Akut (ISPA)	0.7	G04	0.4	0.28	0.196
Infeksi Saluran Pernapasan Akut (ISPA)	0.7	G07	0.6	0.42	0.294
Pneumonia	0.5	G04	0.5	0.25	0.125
Hasil					1.426

Table 4. User Response Example

Users	q 1	q 2	q 3	q 4	q 5	q 6	q 7	q 8	q 9	q 10	q 11	q 12	q 13	q 14	q 15	q 16
01	7	6	7	7	6	N	6	7	6	7	6	7	6	7	7	7
02	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
03	2	5	2	2	3	4	2	4	3	4	3	1	1	4	2	3
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
72	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
73	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
74	7	7	7	7	7	6	7	6	7	7	7	7	6	7	7	6

Based on the substance value of the symptom G03, the probability can be found by dividing the substance value (0.36) by the total probability value of all diseases (1.426), so that the result is 0.36/1.426 = 0.324. While the probability of GEA disease in symptom G04 is 0.18 / 1.426 = 0.162. So the total probability of GEA disease is 0.324 + 0.162 = 0.48.

The substitution of the G04 rule weight and the disease weight is 0.4 x 0.7 = 0.28. The substitution of the G04 rule weight and the disease weight is 0.6 x 0.7 = 0.42. So the probability of ARI disease

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in symptom G04 is 0.28/1.426 = 0.19, and the probability of ARI disease in symptom G07 is 0.42/1.426 = 0.294. So the total probability of ARI disease is 0.196 + 0.294 = 0.49.

Based on the calculation results obtained, Acute Respiratory Tract Infection (ARI) has a high probability level of the diseases that appear in the naïve bayes calculation analysis table. So the disease that may be suffered based on the selected symptoms is Acute Respiratory Tract Infection (ARI).

```
{'System Usefulness': 5.9148148148148145,
 'Information Quality': 5.966666666666666,
 'Interface Quality': 5.897222222222222}
```

Image 3. Average For Each Subscale

Based on the respondent feedback data from the average value of each subscale obtained, the quality of information received the highest score (5.97), indicating that the information provided by the system was considered clear and useful. However, there was little room for improvement in the quality of the interface (5.90) and the usability of the system (5.91).

```
(0     6.594595
 1     6.567568
 2     6.444444
 3     6.333333
 4     6.500000
 5     6.277778
 6     6.421053
 7     6.228571
 8     6.583333
 9     6.388889
 10    6.270270
 11    6.342105
 12    6.243243
 13    6.305556
 14    6.305556
 15    6.605263
 dtype: float64,
 6.400722315360473)
```

Image 4. PSSUQ Score Calculation

The overall average calculation result of the PSSUQ score obtained was 6.40 on a scale of 1 to 7, which indicates a high level of user satisfaction with the system. Most of the questions scored above 6. The question with the highest score was Q16 with an average value of 6.61, while the question with the lowest score was Q8 with a value of 6.23 which is still in the high category. This shows that users find the system easy to use, efficient, and meets their needs.

CONCLUSION

Based on the results of system testing with Black Box, all main features, such as symptom input, classification process, and output of diagnosis results, function properly. The system uses the Naïve Bayes algorithm to calculate the probability of disease based on selected symptoms showing that Acute Respiratory Infection (ARI) has the highest probability compared to other diseases. Meanwhile, the system obtained a high satisfaction score with an average value of 6.40 which indicates that users feel the system is easy to use, efficient, and provides clear and useful information. However, there is still room for improvement in further research on the quality of the interface and usability of the system which is still at a score of 5.90.

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