p-ISSN : 2301-8402, e-ISSN : 2685-368X , available at : https://ejournal.unsrat.ac.id/index.php/elekdankom

Designing Expert System for Diagnosing Cancer with Forward Chaining Method

Keith Francis Ratumbuisang[1], Yosua Fitsgerald Ratumbuisang[2], Dedi Sorongan[3]
Jurusan Teknik Informatika, Universitas Sariputra Indonesia Tomohon, Jl. Perlombaan Tomohon Utara, Indonesia
Email : keithratumbuisang@unsrittomohon.ac.id, yosuafitsgerald.2020@student.uny.ac.id,
Received:05 February 2021; revised: 25 December 2021; accepted: 28 December 2021

Abstract - This study aims to produce software in the form of a Cancer Diagnosis Expert System using a system capable of managing the implementation of general disease diagnosis input in humans, namely registration, filling in symptoms of disease, early diagnosis, and given drugs. This research also tested the feasibility level of the software that has been made. The system development method uses the waterfall method with a 4-stage design, namely Analysis, Design, Coding and Testing. Meanwhile, the method of finding / drawing conclusions is the forward chaining method.. Software testing is done through black-box testing, McCall's Quality Factor as an indicator to determine the feasibility of the software with a measurement scale using a Likert scale. Interviews and questionnaires are techniques used to collect data, while data analysis techniques use quantitative descriptive analysis. The web-based expert system for diagnosing rice plant diseases that has been developed has the advantage of ease of access and ease of use. With its web-based features, the expert system for cancer diagnosis that has been built can be used as a tool for diagnosing various types of cancer and can be accessed by anyone.

Keywords - Expert System, Cancer Disease, Diagnosis, Forward Chaining

I. INTRODUCTION

A. Cancer Disease

Cancer is a disease caused by uncontrolled growth of abnormal cells in the human body[1]. This abnormal cell growth can damage normal cells around and in other parts of the body. Cancer is the second leading cause of death in the world. Cancer usually leads to death, because in general, this disease does not cause symptoms at the beginning of its breeding, so detection and treatment are only carried out after it has reached an advanced stage. The main cause of cancer is genetic changes (mutations) in cells. Genetic mutations will make cells abnormal. In fact, the body has its own mechanism for destroying these abnormal cells. If this mechanism fails, the abnormal cells will grow uncontrollably. The factors that can trigger the growth of cancer cells vary, depending on the type of cancer. However, there is no specific type of cancer triggered only by one factor. Factors that are thought to be at risk of causing genetic mutations in normal cells and failure of the body to repair them include: Have a history of internal cancer, over 65 years of age. However, some types of cancer are more common in children, Smoke, Exposure to radiation, chemicals (such as asbestos or benzene), or sunlight, Infected with viruses, such as hepatitis B, hepatitis C, and HPV, Long-term or high levels of hormone exposure, Experiencing obesity, Lack of movement and do not exercise regularly, Suffering from a disease that causes chronic inflammation (long-term inflammation), such as ulcerative colitis. Decreased immune system, for example due to suffering from HIV / AIDS. To diagnose cancer, the doctor will ask about the patient's symptoms and perform a physical examination. After that, there are several additional tests that the doctor will do to confirm a cancer diagnosis, namely:

Laboratory test

Laboratory tests, such as blood and urine tests, can be done to check for abnormalities in the body. Doctors can also perform tumor marker examinations to detect cancer.

Imaging test

This test can be in the form of an X-ray, ultrasound, CT scan, MRI, or PET scan, to see the condition of the affected organ.

Biopsy

In this procedure, the doctor will take a sample of the patient's body tissue that is suspected of having cancer. A biopsy is the most accurate examination to determine whether a person has cancer or not.

Based on the results of the above examinations, the doctor will determine the level (stage) of the cancer. In general, the cancer grade is divided into stages 1, 2, 3, and 4. The higher the stage of the cancer, the more severe the symptoms of the disease will be and the less likely it will be to recover. The level of cancer is determined based on the size of the cancer, whether or not the cancer has spread to the surrounding lymph nodes, and how far the cancer has spread to other organs. Therefore, it is advisable to carry out periodic health checks to detect cancer early. To prevent cancer, live a healthy lifestyle, which is a balanced diet, not smoking, and not consuming alcoholic. [2]

B. Technology Development

Technology is a means or system that functions to provide comfort and convenience for humans. Therefore, technology is very important in today's era, especially with digital technology that is growing rapidly every day. Nowadays human life cannot be separated from technological

advances, considering that the times have developed rapidly. Technology offers efficiency and quality in people's live.[3] The existence of technology has influenced society and the environment around it along with the times, where technology is able to help in various ways, such as helping to improve the economy. With the development of information technology, the demand for fast and accurate information is very important.[3] Therefore, the existence of a reliable computer system has become an absolute necessity. One of the uses of information technology required is an expert system for doctors to diagnose cancer. A cancer diagnosis expert system can help doctors enter the patient's symptoms, making it easier and very useful if the doctor who examines the patient changes.

C. Expert System

Expert system application is rapidly increasing. Such applications are very affective in situations when the domain expert is not readily available. [4] An expert system is an information system that seeks to apply human knowledge to computers so that computers can solve problems like experts [5]. The concept of information systems is a collection of interconnected elements to form a single unit to integrate data, process, store and distribute information. Expert systems are basically used to support problem-solving activities, through this expert system users can easily obtain quality information from experts in their fields.[6] In addition, expert systems can also help experts with the knowledge needed to assist activities. Expert systems are systems that use human knowledge recorded in computers to solve problems that usually require human expertise [2-3]. A good expert system is designed to be able to solve a certain problem by imitating the work of the experts [5] Expert systems can be presented in two environments, namely: development and consultation. The development environment is used by expert system builders to build components and feed knowledge into the knowledge base. The consulting environment is used by non-experts for knowledge and consultation. [5] To build a functioning system to imitate a human expert must be able do things that can be done by expert. The use of classification systems in medical diagnosis is increasing gradually. [7]To build such a system hence the minimal basic components must-have Interface (user interface), Knowledge base. Inference Engine.[8] The components in the expert system can be seen in Figure 1, namely:

Knowledge base. Contains the knowledge needed to understand, formulate and solve problems.

Inference engine. There are 2 ways that can be done in doing inference, namely first, forward chaining, a group of multiple inferences that searches from a problem to its solution. Forward chaining is data-driven because inference starts with available information and new conclusions are obtained. Second, backward chaining, uses a goal-driven approach, starting with expectations of what you want to happen (hypothesis), then looking for evidence that supports (or contradicts) those expectations.

Blackboard. Is a working area of memory that is stored as a database for a description of the current problem defined by the input data and is also used for recording hypotheses and provisional decision.

Knowledge acquisition subsystem. Knowledge acquisition is the accumulation, transfer and transformation of problem-solving expertise from expert or documented knowledge sources to computer programs to build or expand a knowledge base.

User interface. Used for communication media between users and programs.

Explanation sub system. Used to track responses and provide an explanation of the behavior of expert systems interactively through questions.[5]

The production rule is one a model to represent knowledge. The production code becomes a very frequent reference used by the inference system. Production rules written in the form of an IF-THEN statement . This statement connects the premise section (IF) and the conclusion section (THEN) which is written in the form: IF [premise] THEN [conclusion] This rule can be said as a implication which consists of two parts, namely the premise and the conclusion. If part of the premise fulfilled then the conclusion will be true. The premise part of the production rules can be has more than one proposition. Proposition- the proposition is connected with using the logical AND or OR operator.

As an example:

IF Pain in joint or spine
AND Anemia
AND decreased appetite
AND frequent bleeding or nosebleeds, bleeding gums or bruises
THEN Leukemia Symptoms.

D. Quality Assurance

System quality assurance, which is a protection activity that is implemented in all system processes to provide the data required by the management department to inform system quality problems, so as to ensure that the quality of the system can reach the target. In determining the quality of the system, an aspect of measurement is needed that can be used as a reference for user satisfaction with the system used.[9]

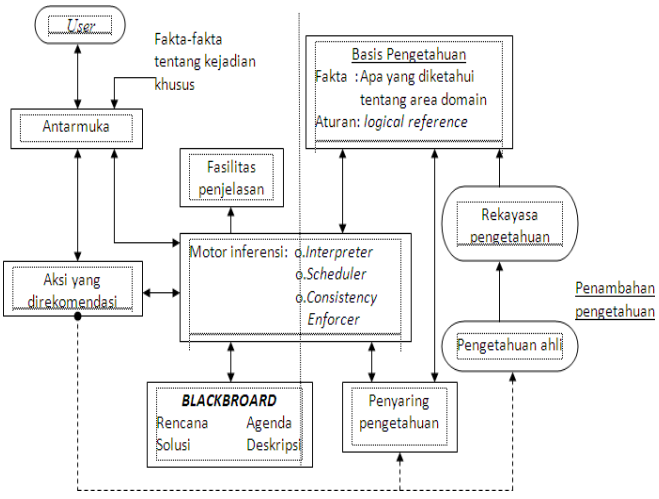

Figure 1. Expert System Structure

p-ISSN : 2301-8402, e-ISSN : 2685-368X , available at : https://ejournal.unsrat.ac.id/index.php/elekdankom

TABLE I. KNOWLEDGE BASE

No	Rules
1	IF Itchy AND Loss of appetite AND Nausea and vomiting AND The body is easy to melt and limp THEN T Liver Cancer Symptoms.
2	IF Pain in joints or spine AND Anemia AND Decreased appetite AND Frequent bleeding or nosebleeds, bleeding gums or bruises THEN Leukemia Symptoms
3	IF Changed breast skin color AND The nipple hurts AND The appearance of a lump on the breast THEN Breast Cancer Symptoms
4	IF The mole gets bigger AND The mole feels sore and doesn't go away AND Change in color of moles AND An unusual shape of a mole AND Experiencing redness or swelling beyond the boundaries of the mole THEN Melanoma Skin Cancer Symptoms.
5	IF Pain during intercourse AND Abnormal vaginal bleeding AND Experiencing unusual vaginal discharge THEN Cervical Cancer Symptoms.
6	IF Eyes are more sensitive to light AND Eyes are more sensitive to light AND Looks spots or blotches when you look in various directions. THEN Eye Cancer Symptoms.

TABLE II. CANCER DIAGNOSIS INFORMATION SYSTEM DESIGN

Analysis	At this stage, find all the information about the software requirements, such as software restrictions on software usage. This information is usually obtained from interviews, surveys or discussions. After that, the information will be analyzed to get complete data about the software requirements to be developed.
Design	The next stage is design. Finish the design before the coding process begins. It aims to provide a complete picture of what to do and what the system should look like. Therefore, it helps to determine the hardware and system requirements and determine the system architecture to be formed as a whole.
Code	Code is being written at this stage. Software / application development will be further divided into small modules, which will be combined at a later stage. At this stage, the finished module will be examined more deeply, regardless of whether it has achieved the required functions.
Test	In this fourth stage, previously produced modules will be combined. After that, testing will be carried out to find out whether the software meets the required design and whether there are still errors.

The components used to measure system satisfaction to satisfy users are as follows

a. Ease of use (learnability) is defined as the speed at which the user is proficient at using the system, the ease of use when performing functions, and what the user is up to.
b. Efficiency refers to the resources expended to achieve target accuracy and completeness.
c. Memorability is defined as the user's ability to retain the knowledge after a certain period of time, and memory capability is acquired by placing a fixed menu.
d. Errors are determined by how many errors the user makes. Errors made by users include a mismatch between what the user thinks and what the system actually reveals.

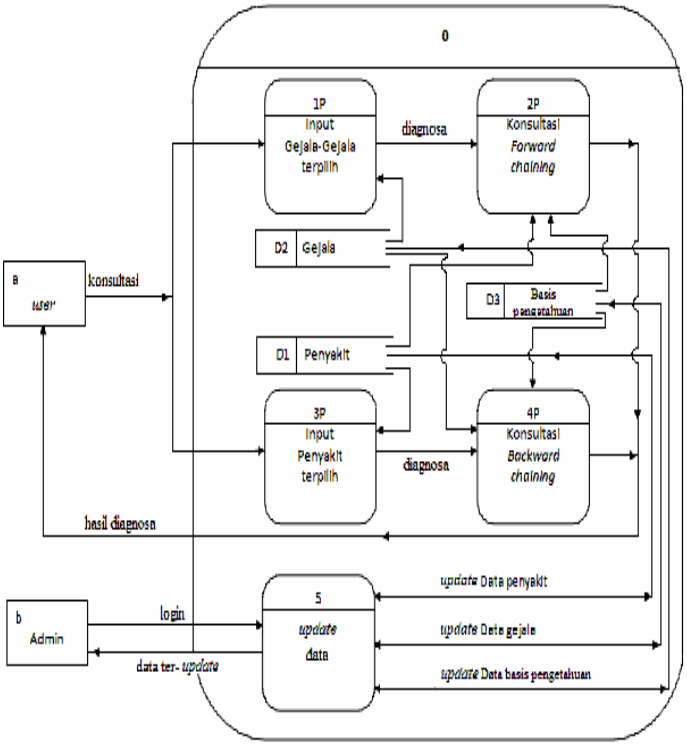

Figure 2. Level 0 Diagram

e. Satisfaction is defined as freedom from inconvenience and a positive attitude towards product use or users' subjective feelings about using the system.

II. METHOD

The research method used is a design using the waterfall model design. The waterfall design model is systematic work that is carried out sequentially or linearly. The design has 4 stages, namely: analysis, design, coding and testing. [10] The table below shows the design of a cancer diagnosis information system based on waterfall model process design.

To find out the data transformation using a data flow diagram (DAD) is a data logic model or process created to describe where the data comes from, where the data comes out of the system, where the data is stored, what processes produce the data, the interaction between data stored and the processes imposed on that data. In the diagram level 0, you can see the entire expert system process with 2 consulting models, namely forward chaining. The level 0 diagram can be seen more clearly in Figure 2

The search method is needed to draw conclusions from the data that has been entered by the user. The method used is forward chaining and backward chaining. The forward chaining method is a method where tracing starts from taking facts first and then using it to draw conclusions. On the other hand, the backward chaining method is a method that starts from a conclusion to look for supporting facts. In this case the symptoms are used as facts, after the entire symptom data are met, it can be used to draw conclusions about a disease

TABLE III. LIVER CANCER SYMPTOMS RELATIONSHIP

Code	Symptoms of Disease
G001	Itchy
G003	Loss of appetite
G006	Nausea and vomiting
G010	The body is easy to melt and limp

TABLE IV. RELATIONSHIP OF LEUKEMIA SYMPTOMS

Code	Symptoms of Disease
G002	Pain in joints or spine
G012	Anemia
G013	Decreased appetite
G017	Frequent bleeding or nosebleeds, bleeding gums or bruises

TABLE V. RELATIONSHIP OF BREAST CANCER SYMPTOMS

Code	Symptoms of Disease
G005	Changed breast skin color
G008	The nipple hurts
G020	The appearance of a lump on the breast

TABLE VI. RELATIONSHIP OF MELANOMA SKIN CANCER SYMPTOMS

Code	Symptoms of Disease
G004	The mole gets bigger
G007	The mole feels sore and doesn't go away
G011	Change in color of moles
G025	An unusual shape of a mole
G026	Experiencing redness or swelling beyond the boundaries of the mole

TABLE VII. RELATIONSHIP OF CERVICAL CANCER SYMPTOMS

Code	Symptoms of Disease
G021	Pain during intercourse
G022	Abnormal vaginal bleeding
G028	Experiencing unusual vaginal discharge

TABLE VIII. RELATIONSHIP OF EYE CANCER SYMPTOMS

Code	Symptoms of Disease
G021	Feeling an unusual pain in the eye
G022	Eyes are more sensitive to light
G028	Looks spots or blotches when you look in various directions.

III. RESULT AND DISCUSSION

Decision making is a method of representing knowledge-based analysis. The design of an expert decision-making system for cancer diagnosis is described at table III to table VIII.

Figure 3. The page contains a login form which functions to enter the system by entering a username and password. The username and password will be given after completing the registration process done by user.

Figure 4. The page contains information about cancer and its types. Users can not only perform symptom analysis but also can get detailed information related to cancer.

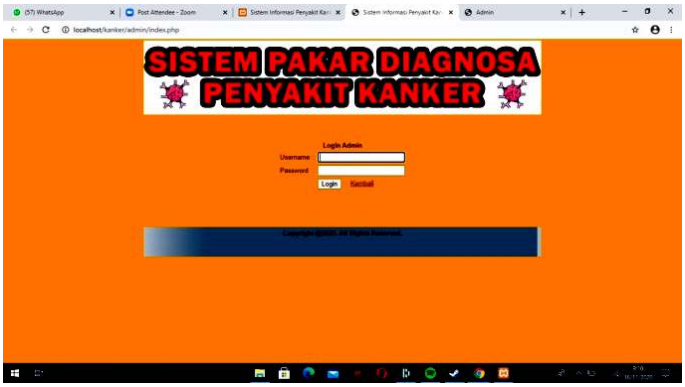

Figure 3. Login Page

Figure 4. Home Page

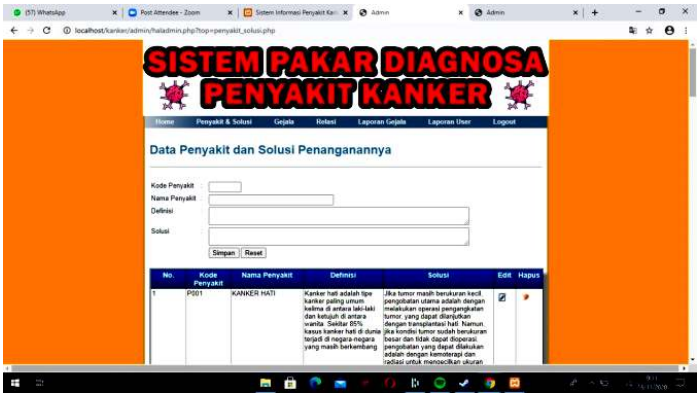

Figure 5. Disease Data Form and Treatment Solutions

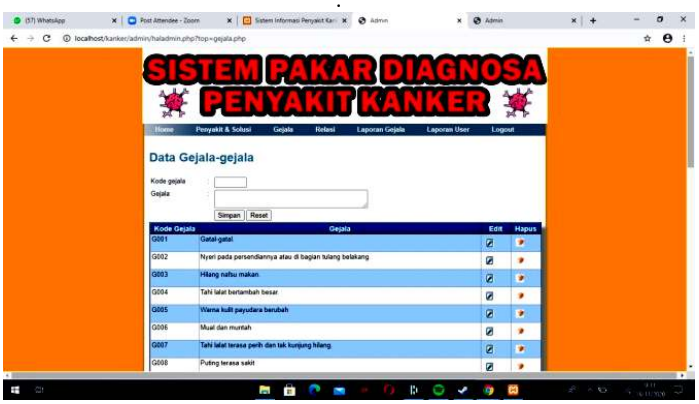

Figure 6. Symptom Data Form

p-ISSN : 2301-8402, e-ISSN : 2685-368X , available at : https://ejournal.unsrat.ac.id/index.php/elekdankom

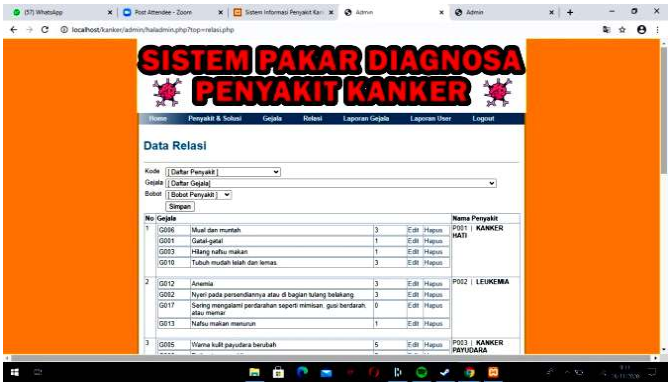

Figure 7. Relationship Data Form

Figure 8. User Data Form

Figure 5. The page contains information about cancer data and treatment solutions. User will be able to study about how to treat patient who got effected by cancer.

Figure 6. The page contains information about the symptoms of cancer for analysis.

Figure 7. The page contains related data for the classification of cancer that will be diagnosed in the system.

Figure 8. This page contains of data of users registered to the system. User's data will record to the system. By recording data, user can control the progress of treatment.

Analysis is used to know the advantages and disadvantages of the application an expert system for diagnosing cancer that has made. The analysis process is carried out with invite or visit respondents. The respondents include an expert medicine specifically for kidney disease, some ordinary people, medical students, and informatics students. The analysis carried out by the designer through the questionnaire includes several components as follows: Interface / system display. Respondents are interested in this system because in terms of the appearance of the system interface which is user friendly, making it easy understood by users. User information , Menu facilities available on this system is sufficient for the needs of users will diagnose the cancer. In terms of system benefits From the doctor's side very interested This expert system application is due to the doctors are very helped by the system this, let alone this system can provide more than one possible disease suffered by the user so that the alternative type other cancers can be picked up by doctors in examining patients, except the possibility of the resulting disease, this system includes magnitude confidence of the symptoms that have been selected by the user against possible disease

This research is successfully designed a cancer diagnosis expert system using the forward chaining method and the PHP programming language, expert systems can negotiate appropriately and provide information about stages, symptoms and solutions, expert systems can provide a diagnosis based on the symptoms experienced by the patient.

As for some suggestions that can be given regarding the development of this expert system are: In this system, it would be better if the chat feature was added where (user) patients can consult with doctors who treat cancer according to their classification. Along with the development, the symptoms of each cancer in the system must be updated so that the accuracy of this system remains good.

The results of the implementation of an expert system for diagnosing cancer diseases with web-based inference methods of forward chaining and backward chaining make it easier to access by anyone (especially farmers) and anywhere (provided an internet network is available).

Application of Expert Systems to the Web

From the client side, web pages can be opened using various browsers such as internet explorer, opera, Mozilla, firofox, and so on. Meanwhile, from the server side, usually by placing the files to a web hosting that supports PHP and MySql languages. Almost all web hosting providers now support PHP and MySql databases.

In this study, forward chaining and applied to facilitate the process of diagnosing cancer. The diagnostic process can be in the form of a consultation starting from asking for symptoms so that information will appear about the cause and steps to treat the disease. The web-based expert system for diagnosing rice plant diseases that has been developed has the advantage of ease of access and ease of use. Applications are easily accessible from various places and on the user side do not need to provide special applications, only need to have a browser application, which usually the browser application already exists at the time of installing the operating system (Windows / Linux).

IV. CONCLUSION AND SUGGESTIONS

Based on the results of the research and discussion that has been done, it can be concluded that:. Expert system application to diagnose cancer is an application to diagnose cancer based on the knowledge of experts. With web-based online access, the public can diagnose the possibility of kidney disease before taking further action such as consulting a doctor or laboratory tests at the hospital. This expert system application can be a means to store knowledge about cancer disease from experts or experts. From the results of the questionnaire, respondents are interested in this system because the interface and system coloring is very user friendly and attractive, and the information provided by the system is sufficient for the user's needs in diagnosing kidney disease. And in terms of benefits, doctors are very interested in the application of this expert system to diagnose kidney disease. Expert systems to diagnose cancer can help uses diagnose types of cancer and provide knowledge about these types of diseases. This system is built to store the expertise knowledge of an expert other than a doctor, so that the system can be used

as a smart assistant in their field as a source of knowledge by the user. The system development is designed in such a way that it can adopt the development of a rule-based reasoning (Rule-Based Reasoning) with forward chaining and backward chaining inference methods. Implementation of an expert system in the form of a web is very helpful in making it easy for users to access it.

V. KUTIPAN

[1] G. A. Calin *et al.*, "Frequent deletions and down-regulation of micro-RNA genes miR15 and miR16 at 13q14 in chronic lymphocytic leukemia," *Proc. Natl. Acad. Sci. U. S. A.*, vol. 99, no. 24, pp. 15524–15529, 2002, doi: 10.1073/pnas.242606799.

[2] S. Frygner-Holm *et al.*, "Pretend Play as an Intervention for Children With Cancer: A Feasibility Study," *J. Pediatr. Oncol. Nurs.*, vol. 37, no. 1, pp. 65–75, 2020, doi: 10.1177/1043454219874695.

[3] M. T. Parinsi and K. F. Ratumbuisang, "Indonesian mobile learning information system using social media platforms," *Int. J. Mob. Comput. Multimed. Commun.*, vol. 8, no. 2, pp. 44–67, 2017, doi: 10.4018/IJMCMC.2017040104.

[4] P. S. K. Patra, D. P. Sahu, and I. Mandal, "An Expert System for Diagnosis Of Human Diseases," *Int. J. Comput. Appl.*, vol. 1, no. 13, pp. 71–74, 2010, doi: 10.5120/279-439.

[5] A. S. Honggowibowo, "Sistem Pakar Diagnosa Penyakit Tanaman Padi Berbasis Web Dengan Forward Dan Backward Chaining," *TELKOMNIKA (Telecommunication Comput. Electron. Control.*, vol. 7, no. 3, p. 187, 2009, doi: 10.12928/telkomnika.v7i3.593.

[6] X. Wang, H. Qu, P. Liu, and Y. Cheng, "A self-learning expert system for diagnosis in traditional Chinese medicine," *Expert Syst. Appl.*, vol. 26, no. 4, pp. 557–566, 2004, doi: 10.1016/j.eswa.2003.10.004.

[7] K. Polat and S. Güneş, "An expert system approach based on principal component analysis and adaptive neuro-fuzzy inference system to diagnosis of diabetes disease," *Digit. Signal Process. A Rev. J.*, vol. 17, no. 4, pp. 702–710, 2007, doi: 10.1016/j.dsp.2006.09.005.

[8] A. Sulistyohati, T. Hidayat, K. Kunci: Ginjal, S. Pakar, and M. Dempster-Shafer, "Aplikasi Sistem Pakar Diagnosa Penyakit Ginjal Dengan Metode Dempster-Shafer," *Semin. Nas. Apl. Teknol. Inf.*, vol. 2008, no. Snati, pp. 1907–5022, 2008.

[9] S. Mahmood, R. Lai, Y. S. Kim, J. H. Kim, S. C. Park, and H. S. Oh, "A survey of component based system quality assurance and assessment," *Inf. Softw. Technol.*, vol. 47, no. 10, pp. 693–707, 2005, doi: 10.1016/j.infsof.2005.03.007.

[10] H. Nur, "Penggunaan Metode Waterfall Dalam Rancang Bangun Sistem Informasi Penjualan," *Gener. J.*, vol. 3, no. 1, p. 1, 2019, doi: 10.29407/gj.v3i1.12642.

TENTANG PENULIS

First Author. Keith Francis Ratumbuisang**,** Bachelor of Education in ICT (Multimedia), Universitas Negeri Manado, Master of Education (Instructional Technology (Universitas Negeri Yogyakarta, Indonesia), Master of Science in Network Learning Technology (National Central University, Taiwan) currently work as lecturer at Universitas Sariputra Indonesia Tomohon in Faculty of Engineering department of Informatics Engineering. His research area includes information system, adaptive hypermedia and e-learning. The research in five years include Indonesian Mobile Learning Information System Using Social Media Platform, Relationship Between Socio-economic Status And Motivation With Study Achievements Of Students In Vocational School, The Effectiveness of i-CRT (i-Critical Reflection on Teaching) Reflection System on Pre-service Teachers' Micro Teaching focusing Meaningful Learning with ICT, Job Seeker Information System Using Online Web-based and Android Mobile Phones.