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Application of the Certainty Factor Method in the Dental Disease Expert System using the Addie Model

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Abstract

Health is one of the basic human needs of many people who pay little attention to health, especially in dental and oral health because dental and oral diseases can attack anyone and at any time. Therefore, the need for fast and precise information from a dentist is needed according to the symptoms of the disease experienced by the patient. There are many factors that make it rare for someone to do an examination and consult a dentist, including a lack of attention or awareness of dental and oral health, the high costs that must be spent for consultations, long queues that make patients uncomfortable waiting. The existence of information system technology is very influential on the progress of the Assalam Dental Clinic. Using the Expert System Certainty Factor Method and the ADDIE model helps doctors recognize the types of dental disease experienced by patients online. The Certainty Factor method is a method for proving whether a fact is certain or uncertain in the form of a metric which is usually used in expert systems. While the Analysis Design Develop Implement Evaluate (ADDIE) model is one of the systematic learning design models, this model is developed or arranged programmatically. The results of the research based on the calculations that have been carried out by means of a combination get the results of dental disease diagnoses with a high percentage level.

Keywords: Expert System, *Certainty Factor*, Model Analysis Design Develop Implement Evaluate, Combination, Teeth

1. Introduction

Health is one of the basic human needs besides food, housing and education, because only in a healthy state can humans live, grow and work better. Many people pay little attention to health, especially to dental and oral health because dental and oral diseases can strike anyone at any time. Therefore, the need for fast and precise information from a dentist is needed according to the symptoms of the disease experienced by the patient [1]. Expert knowledge embodied in the form of applications, the level of solution can be the same as that of the experts, so that users can interact with an expert system computer without having to meet the expert, such as a person suffering from a certain disease can use an appropriate expert system or match the symptoms of the disease to get a solution and advice from expert systems [2].

An expert system is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require an expert to solve them. An expert system is a computer system that is intended to emulate all aspects of the decision making ability of an expert. Expert systems make maximum use of special knowledge like an expert to solve problems [3].

An expert system is a system that seeks to adopt human knowledge into computers, in order to be able to solve problems that are usually done by experts [4] like an expert or someone who has expertise in a particular field, namely an expert who has special knowledge or abilities that are not known and owned by other people [5].

The purpose of an expert system is to transfer the expertise of an expert into a computer and then transfer it to other people who are not experts. This process involves four processes, namely additional knowledge (from experts or other sources), knowledge inference, knowledge representation (on a computer), transfer of knowledge to users, inference. Inference is a procedure (program) that has the ability to do reasoning. Inference is displayed on a component called the inference engine which includes procedures regarding problem solving [6].

Certainty factor is a method for proving whether a fact is certain or uncertain in the form of a metric which is usually used in expert systems. This method is very suitable for expert systems that diagnose something that is not certain. Dempster-Shafer is a mathematical theory for proof based on belief functions and plausible reasoning, which are used to combine separate pieces of information (evidence) to calculate the probability of an event [7]. Certainty Factor is part of certainty theory, which was first put forward by EH Shorliffe and BG Buchanan in making MYCIN (is an early expert system application designed to identify infections in the blood) noting that experts often analyze existing information with phrases such as, for

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example : maybe, most likely, and almost certainly. This made the MYCIN team use the Certainty Factor to describe the level of expert confidence in the problem at hand. This certainty factor method can only process 2 weights in one calculation. For weights that are more than 2 in number, to carry out calculations there is no problem if the weights are calculated randomly, meaning that there are no rules for combining the weights, because for any combination the result will be the same [8] .

Previous research on the Certainty Factor method has been able to diagnose cholesterol and gout with a system accuracy of 80% [9]. Other studies using the Certainty Factor method have been able to detect broiler chicken diseases with a system accuracy of 90% [10]. Other studies using the Certainty Factor method have been able to diagnose dermatitis with a system accuracy of 90% [11]. Other studies using the Certainty Factor method have been able to diagnose spinal cord disease with an accuracy test result of 90% [12]. Other studies using the Certainty Factor method have been able to identify facial skin types with the results of a system confidence level of 95.33%. Other research using the Certainty Factor method has been able to detect the determination of the learning style of adolescent children with the results for case 1 with a kinesthetic learning style (83.4 %), case 2 with an audio learning style (77.4%), for case 3 with a learning style audio (78.1%) [13].

The Analysis Design Develop Implement Evaluate (ADDIE) model is one of the systematic learning design models, this model is developed or arranged programmatically with systematic sequences of activities in an effort to solve learning problems related to learning resources that suit the needs and characteristics of the system [7]. The ADDIE model is a model that is considered more rational and more complete than other models. Therefore, this model can be used for various forms of product development such as models, learning strategies, learning methods, media, and teaching materials. The ADDIE model is also a model in designing systems using a systems approach in dividing the learning planning process into several steps in a logical sequence, then the outputs of each step serve as input for the next step [14] . One of the functions of ADDIE is to serve as a guide in building training program tools and infrastructure that are effective, dynamic and support the performance of the training itself [15].

There are many factors that cause it is rare for someone to do an examination and consult a dentist, including a lack of attention or awareness of dental and oral health, the high costs that must be spent for consultations, long lines that make patients uncomfortable waiting [16].

With the implementation of an expert system application for diagnosing dental disease, it is hoped that it will be able to provide information about dental disease to the wider community and be used for early diagnosis of dental disease. And provide accurate diagnosis of symptoms worthy of an expert/doctor.

2. Research methodology

To assist in the preparation of this research so that the steps in solving the problems to be discussed can be clearly structured, it is necessary to have a framework arrangement. The research framework contained in Figure 1:

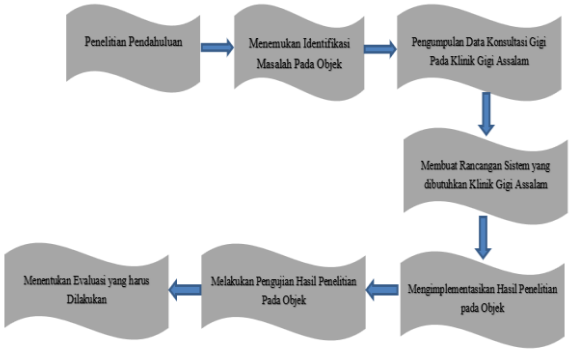


Figure 1. Research Framework

The research stage is a sequence of processes or steps that will be carried out in completing this research. The stages of this research are as follows:

2.1 Preliminary Research

Before conducting research, researchers will first conduct preliminary research to explore whether or not a research can be carried out in the area and the intended object. With this activity, the researcher wants to know whether the research plan has the possibility to be implemented . This research was carried out at the Assalam Dental Clinic which is located at Jln. Gajah Mada, Padang City, West Sumatra, where the researchers collected data by interviewing the dentist drg. Putri Dwi Okmalida immediately

2.2 Research Library (Library Research)

This library research was carried out by reading journals, books, the internet, articles that discussed Certainty Factors and those related to expert systems. So that the data obtained can be used as a basis for further research stages.

2.3 Analysis

Based on the problem identification above, the researcher conducted data analysis first. This is so problem solving can produce new solutions.

2.4 System planning

At the expert system design stage with the web-based Certainty Factor method as the output of the system to be run.

2.5 System Implementation

System implementation is the stage of laying the system so that it is ready to operate. Implementation aims to confirm the design capital, so that users can provide input to the development of dental disease applications. At this stage the design of this application is done using the programming language PHP (Hypertext Preprocessor) and MySQL database.

2.6 Testing

From the process of implementing the application, it can be implemented, after it can run, then testing the program that has been produced and carrying out repairs or development of the program if there are errors and deficiencies in the program.

2.7 Evaluation

Evaluation is a step taken to evaluate the results of system testing. If the results of system testing are in accordance with the results of analysis and design, then the system can be applied to research sites to help solve existing problems, but if the system that has been tested is not in accordance with the results of analysis and design, it is necessary to re-analyze the system and look for where the error lies. existing in the system before being applied to the research site. After an error is found in the system, repairs are made to the system and testing is carried out again until the system is in accordance with the results of the analysis and design and is ready to be applied to the research site.

3. Results and Discussion

3.1 Certainty Factor

Calculation steps in the *certainty factor method* to build a dental diagnosis expert system are as follows:

1. Determination of dental disease data

Disease data that will be used for the expert system for diagnosing dental disease can be seen in Table 1 below:

Table 1. Disease Data

No	Disease code	Disease Name
1	P01	*Periodontal Abscess*
2	P02	*Periapical Abscess*
3	P03	Tooth Abrasion
4	P04	*Bruxims*
5	P05	*Gingivitis* (Gingivitis)
6	P06	*Caries* (Tooth Cavities)
7	P07	Tooth Fracture
8	P08	*Periodontitis*

From the table above it can be seen that there are 8 dental disease data with codes ranging from P01 to P08.

2. Determination of symptom data

The symptom data that will be in this study are as many as 20 symptoms of dental disease which can be seen in Table 2:

Table 2. Symptom Data

No	Symptom	Symptom Name
1	G001	Hard to chew.
2	G002	Swelling or inflammation of the gums.
3	G003	Loose teeth.
4	G004	Jaw swelling occurs.
5	G005	Swollen lymph nodes around the jaw or neck.
6	G006	Fever.
7	G007	Bad breath.
8	G008	Pain or soreness around the gums.
9	G009	Teeth feel sore and sensitive.
10	G010	Tooth shape looks eroded.
11	G011	Insomnia or feeling restless.
12	G012	Headache.
13	G013	Cavity.
14	G014	Gums bleed easily.
15	G015	The shape of the gums is slightly rounded.
16	G016	There is plaque on the teeth.
17	G017	Teeth like eroded.
18	G018	Pain that can appear and disappear suddenly.
19	G019	Tooth pain when chewing / biting.
20	G020	There is pus coming out between the teeth and gums .

Symptoms of dental disease obtained as many as 20 symptoms with each symptom given a code from G01 to G20 as in the table above.

3. Defining Rules

The knowledge gained will be presented to
in the form of a rule that is useful for finding conclusions about the type of dental disease. The way to get the confidence level (CF) of a rule that researchers use is by interviewing an expert. The CF (Rule) value is obtained from the "term" interpretation of the expert, which is converted into a certain CF value according to Table 3

Table 3 . *Certainty Factor* Condition Value

No	Condition	CF value
1	Definitely Yes	1
2	Almost Definitely Yes	0.8
3	Most likely Yes	0.6
4	Maybe yes	0.4
5	Don't know	0

Table 4 . Weight Rule Data

No	Disease Name	Symptom Code	MB	MD	Expert Certainty Factor
1	*Periodontal Abscess*	G001	0.8	0.4	0.4
2		G002	0.8	0.4	0.4
3		G003	0.6	0.4	0.2
4	*Periapical Abscess*	G001	0.8	0.4	0.4
5		G004	1	0.4	0.6
6		G005	0.8	0.4	0.4
7		G006	1	0.6	0.4
8	Tooth Abrasion	G007	1	0.4	0.6
9		G008	0.8	0.4	0.4
10	*Bruxims*	G009	0.6	0.4	0.2
11		G010	1	0.4	0.6
12	*Gingivitis*	G005	0.8	0	0.8

No	Disease Name	Symptom Code	MB	MD	Expert Certainty Factor
13	(Gingivitis)	G014	0.6	0.4	0.2
14		G015	1	0.4	0.6
15	*Caries* (Tooth Cavities)	G003	1	0.4	0.6
16		G007	0.6	0.4	0.2
17		G009	0.6	0.4	0.2
18		G010	0.6	0.4	0.2
19		G013	0.8	0	0.8
20		G016	0.8	0.4	0.4
21		G019	1	0.4	0.5
22	Tooth Fracture	G009	0.8	0	0.8
23		G010	0.8	0.4	0.4
24		G015	1	0.4	0.6
25		G017	0.8	0.4	0.4
26		G018	1	0.4	0.6
27		G019	0.8	0.4	0.4
28	*Periodontitis*	G002	0.8	0	0.8
29		G003	0.6	0.4	0.2
30		G007	1	0.4	0.6
31		G014	1	0.4	0.6
32		G016	0.8	0.4	0.4
33		G019	0.8	0	0.8
34		G020	0.8	0.4	0.4

The last step is to combine the CF values and each rule, combine CF1 to CF5 with the following equation :

$CF_{COMBINE}(CF_1, CF_2) = CF_1 + CF_2 * (1 - CF_1)$
$= 0.8 + 0.4 * (1 - 0.8)$
$= 0.8 + 0.4 * 0.2$
$= 0.8 + 0.08$
$= 0.88\ C_{Fold\ 1}$

$CF_{COMBINE}(C_{Fold1}, CF_3) = 0.88 + 0.6 * (1 - 0.88)$
$= 0.88 + 0.6 * 0.12$
$= 0.88 + 0.072$
$= 0.952\ C_{Fold2}$

$CF_{COMBINE}(C_{Fold2}, CF_4) = 0.952 + 0.4 * (1 - 0.952)$
$= 0.952 + 0.4 * 0.048$
$= 0.952 + 0.019$
$= 0.971\ C_{Fold\ 3}$

$CF_{COMBINE}(C_{Fold3}, CF_5) = 0.971 + 0.6 * (1 - 0.971)$
$= 0.971 + 0.6 * 0.029$
$= 0.971 + 0.017$
$= 0.988\ C_{Fold4}$

Percentage = $CF_{COMBINE} * 100\%$
$= 0.988 * 100\ \%$
$= 98.8\ \%$

The conclusion from the results of the combination of the CF values above can be diagnosed as a user suffering from Dental Invoice with a certainty level of 0.988 or 98.8 % .

3.2 Testing System Interfaces

The following is an implementation of the *certainty factor method* using the PHP programming language supported by the MySql database, as follows:

1. Display of Patient Data Pages

On this page *the user* can fill in the patient's personal data before conducting a consultation to get a diagnosis.

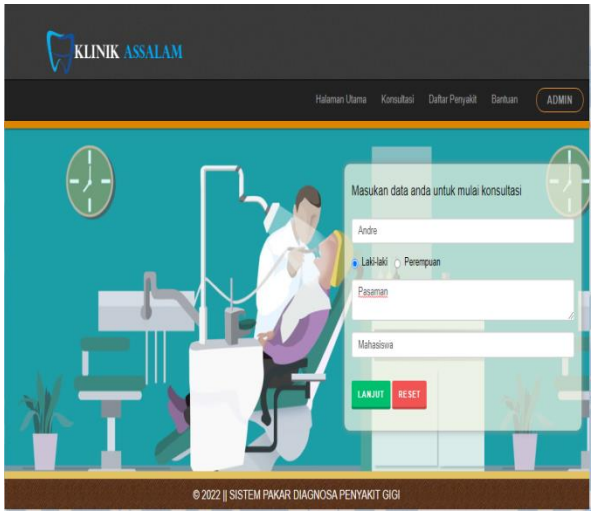


Figure 2. Patient Personal Data Page

2. Consultation Page

On this page *the user* can select the symptoms that are felt about dental disease and the system will process the symptoms with the *Certainty Factor method* to get a diagnosis.

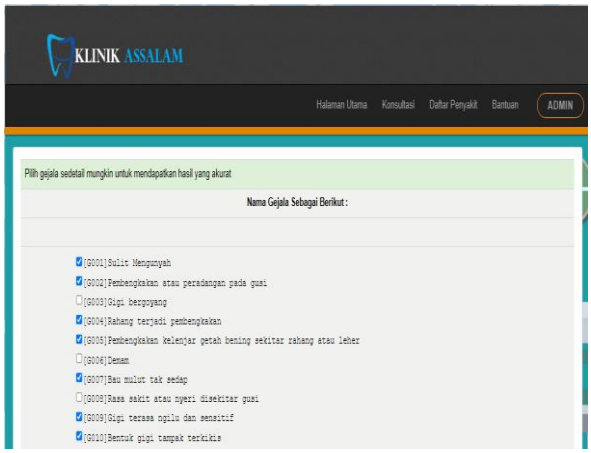
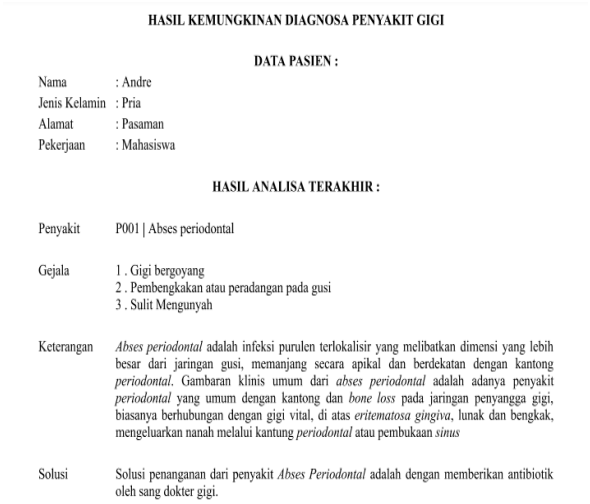


Figure 3. Consultation page for selecting symptoms

3. Consultation Result Page

This page will display the results of consultation diagnoses that have been carried out by *the user* and their handling. *Users* can re-consult and see the details of the consultation results. The following is a picture of the consultation results page:



HASIL KEMUNGKINAN DIAGNOSA PENYAKIT GIGI

DATA PASIEN :

Nama	: Andre
Jenis Kelamin	: Pria
Alamat	: Pasaman
Pekerjaan	: Mahasiswa

HASIL ANALISA TERAKHIR :

Penyakit	P001 | Abses periodontal
Gejala	1 . Gigi bergoyang 2 . Pembengkakan atau peradangan pada gusi 3 . Sulit Mengunyah
Keterangan	*Abses periodontal* adalah infeksi purulen terlokalisir yang melibatkan dimensi yang lebih besar dari jaringan gusi, memanjang secara apikal dan berdekatan dengan kantong *periodontal*. Gambaran klinis umum dari *abses periodontal* adalah adanya penyakit *periodontal* yang umum dengan kantong dan *bone loss* pada jaringan penyangga gigi, biasanya berhubungan dengan gigi vital, di atas *eritematosa gingiva*, lunak dan bengkak, mengeluarkan nanah melalui kantung *periodontal* atau pembukaan *sinus*
Solusi	Solusi penanganan dari penyakit *Abses Periodontal* adalah dengan memberikan antibiotik oleh sang dokter gigi.

Figure 4 Diagnostic Results Page

4. Conclusion

By designing a clinician and patient expert system to be more selective in conducting consultations and diagnosing dental diseases online on the Assalam Dental Clinic website and applying the certainty factor method using the addie model in the expert system, it is expected to provide precise and accurate results of dental disease analysis in patients.

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