

Application of Fuzzy Logic Sugeno Method for Diagnosis Yellow Fever

Trismayanti Dwi Puspitasari*
Techonolgy Infromation Department
Politeknik Negeri Jember
Jember, Indonesia
trismayanti@polije.ac.id

Ria Chandra Kartika
Public Health Department
Politeknik Negeri Jember
Jember, Indonesia
riachandrakartika@gmail.com

Jazil Ramadhanty
Techonolgy Infromation Department
Politeknik Negeri Jember
Jember, Indonesia
dhanty12@gmail.com

Abstract— The Infant Mortality Rate (IMR) is one of the main components to determining the degree of health and welfare people in the country. Indonesia is quite high IMR rate compared to Southeast Asian for of yellow fever. This fever usually appears in babies called new born jaundice. Babies can experience physiological and pathological depending on the symptoms. Parents often have difficulty distinguishing the difference between normal and severe fever without further examination, so that they do wrong in the initial treatment. Responding to the problems, it is necessary to conduct research on "Application of Fuzzy Logic Sugeno Methods for Diagnosis Yellow Fever". The aim of this research to minimizing IMR because this application can be used anytime and anywhere before being taken to the hospital. Sugeno Fuzzy logic is suitable method because it is very flexible to accepts tolerance for data that is not completely correct or wrong when they confused in determining the level of severity. This application will be carried out with an evaluation by expert using UAT (User Acceptance Testing) method to validation and verification. The output of this application is able to provide information about the percentage of the severity of yellow fever, history of diagnosis so that the condition of each user who uses the system can be monitored, initial treatment solutions.

Keywords—application, detection, fuzzy Sugeno

I. INTRODUCTION

Life expectancy is an indicator in the health sector, but there is another important measure, namely the number of infant or children who die. They are more susceptible to disease and unhealthy living conditions, therefore the fourth goal of the Millennium Development Goals (MDGs) is to reduce the number of child deaths [1]. One of the main components in determining the degree of health and welfare people in the country, which is seen from the Infant Mortality Rate [2]. By looking at the infant mortality rate, we know that the quality of a country's health seen by the infant mortality rate. If it is high so the quality of country's health is relatively low. In Indonesia, the infant mortality rate is currently low. The results of the Indonesian Demographic Health Survey (IDHS) in 2017 the infant mortality rate was recorded at 24 per 1000 live births, which means 1 of the 42 babies died in the first year of life. This figure is already lower than the 2012 IDHS, which shows the infant mortality rate of 32 per 1000 live births [3]. Although the mortality rate has decreased, however, the infant mortality rate in Indonesia is still high compared to other ASEAN countries such as

Vietnam, Brunei Darussalam, Thailand, Malaysia and Singapore (Ministry of Women's Empowerment and Child Protection and the 2018 Central Bureau of Statistics).

Yellow fever is often called jaundice or neonatal jaundice occurs in newborns (0-1 months of age). It is a yellow stain that appears on the sclera (white membrane of the eye) and baby's skin caused by a buildup of bilirubin (yellow pigment in bile, blood and stool). It is divided into two, namely physiological jaundice and pathological jaundice. Physiological jaundice can be seen that the yellow symptom still at a normal stage in newborns. The newborn's liver function is not work optimally. Pathological jaundice is a symptom of abnormal jaundice in infants that can be caused by a disease that attacks liver function [4]. Babies who diagnosed pathological jaundice need special treatment, namely light therapy to prevent symptoms become more worse [5]. Jaundice almost have the same symptoms, so that parents difficult to distinguish without further examination by a doctor. Meanwhile, baby examinations at the public health only once a month in Posyandu. Lack of awareness from parents became a high-risk infant death for babies.

The objective of this research is to create an website application for the diagnosis of a yellow fever so that users can access easily anywhere and anytime. It is able to provide information about the percentage of the severity of jaundice, history of diagnosis so the user can be easily to monitor, solutions based on the percentage of severity so the user can take fast response before checked to the nearest hospital. The final results of this system will be carried out in an evaluation stage before being launched or published to the user. The verification will be carried out to the experts, namely doctors and carried out market tests using the (UAT) User Acceptance Testing method to determine the percentage of the level of acceptance of information systems in the community.

II. RELATED WORKS

The growth of information technology is increasing lately, person gain the information from website. The collaboration between website and expert will help people to make an application that can think like an expert [6]. Web based application are cross platform and easily accessible. It is accessible anywhere and anytime, throughout you have access to a device with an internet connection [7]. Fuzzy logic is very

flexible and very simple mathematical concept that is easy to understand. The Sugeno is a method that corrects weaknesses that are owned by pure fuzzy[8]. The Sugeno fuzzy logic is consequent in the form of equation constants by Sugeno order zero and seemingly from the research results gained by the error value most low, so it can be said to be close to zero[9]. The Fuzzy Sugeno can integrated with Neural Networks (NN), Genetic Algorithm (GA) or other optimization techniques method so the system can fit to the system characteristic efficiently [10].

III. METHODS

The research method is a prototype. Prototypes are beneficial for getting requirements, generating user feedback and identifying, verifying or mitigating risks in a project [11]. It is an iterative, trial-and-error process that happens among the developers and the users [12]. There are 5 steps shown at Fig 1: communication, quick plan, modeling quick plan, construction of prototype, development delivery and feedback.



Fig. 1. Prototype Method

Communication is the meeting during process to ensure requirement application run effectively by communication between analyst and the client. Mostly errors this stage is due to poor communication between them [13]. Communication can do by collecting data with interview or observation or literature or questioner. In this research will do communication with doctor, cadre in Posyandu and parents.

The quick plan step is a simple design of the system created but it is not a full design. It gives a shorter idea of the system to the user. It will help in developing the prototype and shown with a functional requirement and non-functional requirement. Modeling quick design is implementation from last step into diagram and data flow diagram.

The construction of prototype is designed mock up based on the information collected from modeling quick design. This design is implemented into code program based on web platform called deployment step. The last step of developing is check the feedback to know the accurate of system before launch into client. This method is cycle so it should be come back to client to communication and show proposed system. It is presented to the client for an initial evaluation. It helps to find out the power and lack of the system. Correction are collected from the client and provided to the developer for the

best result. You need to refine according to the client’s feedback. This step will not over until all the requirements client are fulfilled.

IV. RESULT AND DISCUSSION

A. Communication

Conduct a problem analysis regarding the infant mortality rate in Indonesia, which is still relatively high compared to other countries. After reviewing the Ministry of Health's research results, it was found that several provinces had the highest contributor to infant mortality, one of which was East Java. In the 2017 East Java BPS data, it was found that Jember Regency was included in the three districts with the highest infant mortality rates, so this problem requires special attention. Of the several causes of death in infants, one of them is due to jaundice in new-born’s (Jaundice Neonatorum) which cannot be distinguished in severity so what often happens is the wrong handling process. From these problems, an information system is needed that can provide information about neonatal jaundice and proper handling methods so that it can reduce infant mortality due to neonatal jaundice.

After obtaining a solution to the problems that occurred, a literature study was carried out by reading books and various journals from previous research and conducting interviews with a doctor. The following is a list of questions about and answers that the author gets after conducting the interview shown in Table I.

TABLE I. TABLE OF INTERVIEW

No	question	Answer
1	What is the characteristics of a baby which affected by symptoms of jaundice?	Jaundice suffered by babies can be classified into 2 types, namely normal (physiological) jaundice and abnormal (pathological) jaundice. Of the two types of jaundice, they have almost the same symptoms, such as a baby's skin that looks yellow to greenish, does not want to drink breast milk (ASI), the sound of the baby's crying is very high, the baby's stool is pale and the level of blood bilirubin (yellow pigment) increases.
2	How to distinguish between the symptoms of a baby having physiological (normal) and pathological (dangerous) jaundice?	The symptoms of the two types of jaundice are almost the same in fact, it is quite difficult to distinguish if only seen from the physical symptoms. Further laboratory tests of the baby's bilirubin levels are needed. But apart from physical symptoms and examination, it can also be seen from the factors that influence the occurrence of jaundice in babies.
3	What factors can affect a baby having jaundice?	Factors that affect jaundice in babies are the gestational age when the baby is born such as being born at a premature or normal age, the baby's weight, and the degree of jaundice experienced by the baby by looking at the distribution of yellow in the baby's limbs and the history of the baby's mother's pregnancy.
4	How detailed are the categories of each factor?	The categories of each factor, first for gestational age can be classified into preterm age (premature), term (normal) and over months (postterm). Second, the baby's weight is classified into low birth weight, moderate birth weight (normal) and over birth weight. For the degree of jaundice, referring to the Kramer Method, it can be divided into 5, namely the degree of jaundice 1 in the head and neck area, 2 to the upper body, degree of jaundice 3 to the lower body to the legs,

No	question	Answer
		degree of jaundice 4 to the arm, lower leg, knee and jaundice 5 degrees to the palms and feet. If for a history of pregnancy such as a baby's mother who has previously had a baby with symptoms of jaundice or not.
5	Is the treatment required by infants with physiological jaundice as the same as with pathological jaundice?	The treatment of babies suffering from physiological jaundice is clearly different from that of babies suffering from pathological jaundice. Because when the baby experiences jaundice normally (physiologically) the parents can take care of the baby independently. But when the baby has pathological jaundice, parents must act carefully. Treatment should be carried out by a more skilled person, namely a doctor.
6	How to cure a baby who has jaundice symptoms according to the type of jaundice being suffered?	When a baby with physiological jaundice can be treated by exposing the baby to the sun for some time. With such treatment, jaundice in babies can gradually disappear. But if the baby with pathological jaundice can not if it is done in the sun only. The treatment that is done must first look at the severity of the jaundice that occurs. If the pathological jaundice is still quite severe, phototherapy can be performed on the baby. If the pathological jaundice is severe, the baby is required to have a blood transfusion so that the jaundice in the baby can be resolved quickly.

B. Quick Plan

Data is obtained after conducting the interview process, and can identify the needs that will be used to build a system both functional and non-functional requirements. The user of this system are admin and general user who need this website to solve their problem. The input of this system are age, weight, jaundice degrees will process by fuzzy Sugeno shown in fig 2.

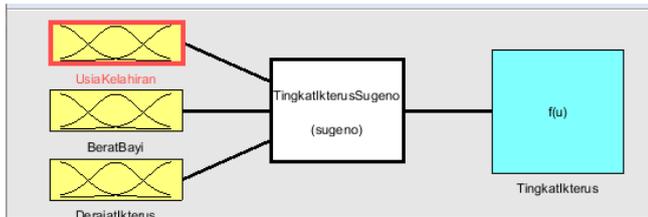


Fig. 2. Proses Fuzzy Sugeno

The input of fuzzy Sugeno variable is shown in table II and revealed in the fuzzification process on figures 3 to 5.

TABLE II. INPUT VARIABEL

No	variable	category	Value
1	age	premature	28 – 36 weeks
		Normal	36 – 40 weeks
		postrema	41 - 43 weeks
2	Weight	less	1800 – 2500 gram
		normal	2500 – 3500 grams
		more	3500 – 4000 grams
3	degress	Normal	0 – 1
		enough	2 – 3
		high	3 - 5

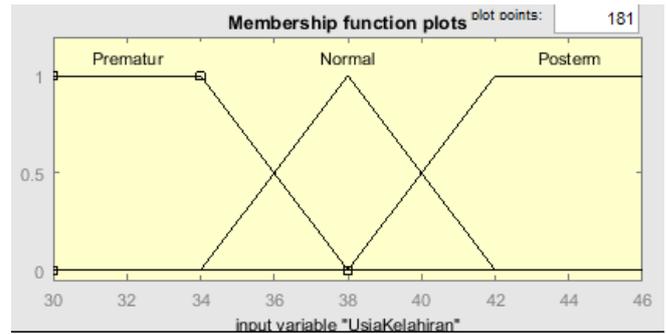


Fig. 3. Membership Function of Age

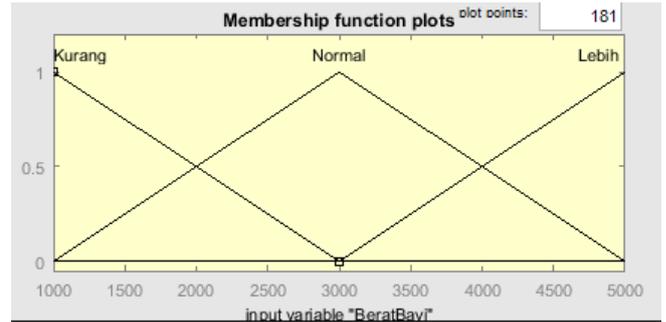


Fig. 4. Membership Function of Weight

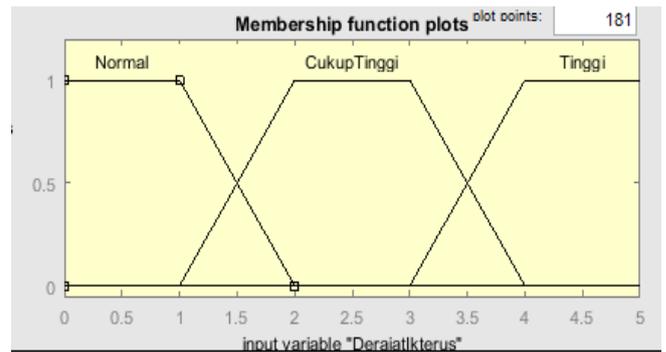


Fig. 5. Membership Function of Jaundice degress

C. Modeling Quick Design

An analysis of the system design built by modeling the system by diagram and data flow diagram show on fig 6-7. The system has two users namely admin and normal user. Admin can enter admin data, membership data, variable data and rule data. From the data entered, the admin gets admin account information, variable information, membership information and regulatory information from the system. For users, they can enter diagnostic data, baby data and user account data. From the data entered by the user in the system, the user can receive information on diagnosis results, baby information and user account information.

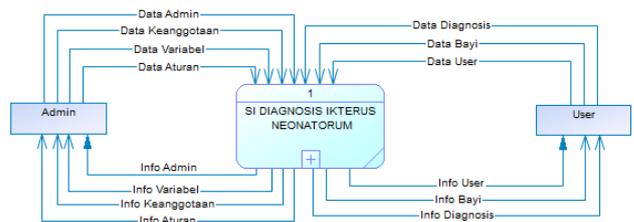


Fig. 6. Diagram Context

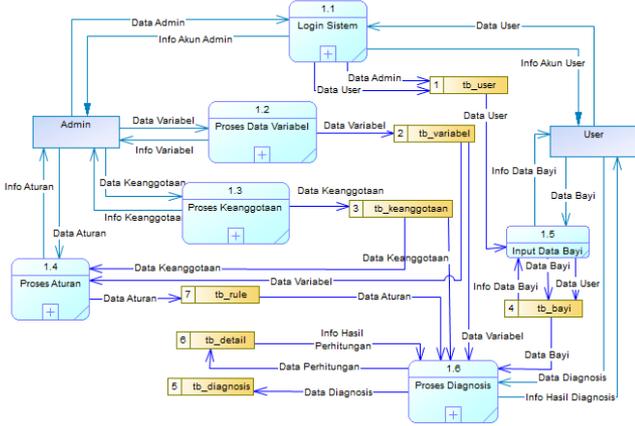


Fig. 7. Data Flow Diagram

D. Construction Of Prototype

This step is carried out development of the system design that has been made previously shown in fig 8 shown about the features of the system. Fig 9 shown a diagnosis feature who user input the variable. Fig 10 shown a result of diagnosis, the result and the percentage degrees of jaundice.



Fig. 8. Dashboard

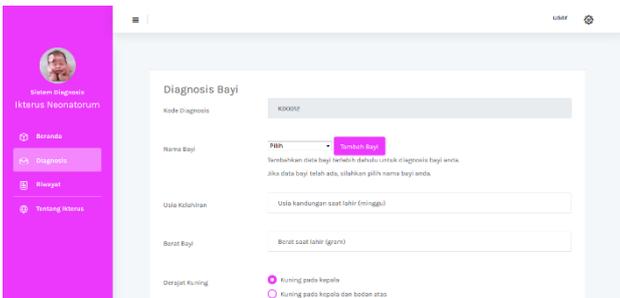


Fig. 9. Diagnosis Feature

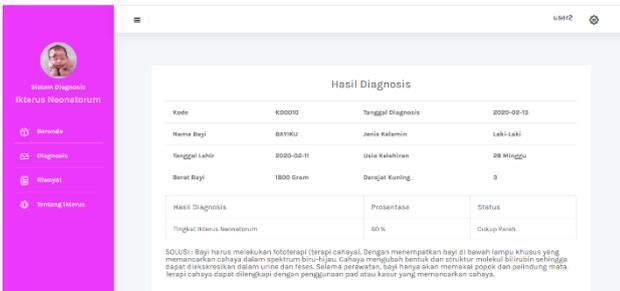


Fig. 10. Result Diagnosis Feature

E. Deployment Delivery and Feedback

Blackbox testing is a functionality test on the system. This test aims to determine the function of all features on the system that are running according to the scenario or not. There are 10 questions about the usability of interface system in the questionnaire distributed to users with 5 answer choices, namely strongly disagree, disagree, normal, agree and strongly agree. The calculation of five user's answer is completed with the percentage of the answers for each answer choice. The result of questionnaire shown in table III. From the Table IV we can said that the system running in 77,87 % it means very good for usability testing.

TABLE III. THE RESULT OF QUESTIONNAIRE

No	Question	Value			Average of percentage (%)
		Amount	Average	%	
Usability					
1	Is the information provided by the system easy to understand?	20	4	80	77,6%
2	Is the location of the menu on the system easily recognized or seen by the user?	23	4,6	92	
3	Is this system easy to learn and understand?	18	3,6	72	
4	Is the system display comfortable to use for the user?	17	3,4	68	
5	is the system display attractive?	19	3,8	76	
User Satisfaction					
1	Can this system solve user problems?	20	4	80	76%
2	Is the system running according to user expectations?	18	3,6	72	
3	what is the level of user satisfaction ?	20	4	80	
Metric System					
1	Is the menu on the system can be run properly?	20	4	80	80%
2	Are the buttons in the menu working properly?	20	4	80	
Average					77,87%

TABLE IV. THE LEVEL OF CRITERIA RESULT

No	Score (%)	Criteria
1	20,00 – 36,00	Poor
2	36,01 – 52,00	Fair
3	52,01 – 68,00	Good
4	68,01 – 84,00	Very Good
5	84,01 - 100	Excellent

V. CONCLUSION

The system is able to provide information about the percentage of the severity of jaundice, history of diagnosis so the user can be easily to monitor, solutions based on the percentage of severity so the user can take fast response before checked to the nearest hospital using fuzzy Sugeno method. The verification result carried out to the experts, namely doctors with 80 % accuracy and carried out market tests using the (UAT) User Acceptance Testing method with 77,87% accuracy result.

ACKNOWLEDGMENT

The authors express their sincere gratitude to Politeknik Negeri Jember for PNPB research scheme funding which supported the research reported in this paper.

REFERENCES

- [1] Stalker, P.: Millennium development goals. (2008).
- [2] Kurniawan, R., Melaniani, S.: Hubungan Paritas, Penolong Persalinan dan Jarak Kehamilan dengan Angka Kematian Bayi di Jawa Timur. *J. Biometrika dan Kependud.* 7, 113 (2019). <https://doi.org/10.20473/jbk.v7i2.2018.113-121>.
- [3] Kementerian Pemberdayaan Perempuan dan Perlindungan Anak dan Badan Pusat Statistik: Profil Anak Indonesia. , Jakarta (2018).
- [4] Baginda, P, H.: Gangguan Perkembangan Neurologis Pada Bayi Dengan Riwayat Hiperbilirubinemia Neurodevelopmental Disorder Among Babies With History Of Hyperbilirubinemia, <https://core.ac.uk/download/pdf/11716507.pdf>, (2007).
- [5] Trihono PP, Windiastuti E, Pardede SO, Endyarni B, A.F.: Pelayanan Kesehatan Anak Terpadu. Departemen Ilmu Kesehatan Anak FKUI RSCM (2013).
- [6] Sevani, N., Joshua, M.: Implementasi Forward Chaining Untuk Diagnosa Defisiensi Vitamin Larut Dalam Lemak Berbasiskan Web. *Informatika.* 10, 51–59 (2014).
- [7] Miller, M.: Cloud Computing: WebBased Applications That Change the Way You Work and Collaborate Online. Que Publishing, America (2008).
- [8] Santosa, I., Rahmanita, E., A'Yuni, T., Novianti, T.: Application of Fuzzy Logic Sugeno Methods for Diagnosis Typhoid Fever Disease and Dengue Hemorrhagic Fever. *ICCSET.* (2018). <https://doi.org/10.4108/eai.24-10-2018.2280495>.
- [9] Yulianto, T., Komariyah, S., Ulfaniyah, N.: Application of fuzzy inference system by Sugeno method on estimating of salt production. *AIP Conf. Proc.* 1867, (2017). <https://doi.org/10.1063/1.4994442>.
- [10] Shleeg, A.A., Ellabib, I.M.: Comparison of Mamdani and Sugeno Fuzzy Inference Systems for the Breast Cancer Risk. *Int. J. Comput. Electr. Autom. Control Inf. Eng.* 7, 1343–1347 (2013).
- [11] Devadiga, N.M.: Tailoring architecture centric design method with rapid prototyping. In: 2017 2nd International Conference on Communication and Electronics Systems (ICES). pp. 924–930 (2017). <https://doi.org/10.1109/CESYS.2017.8321218>.
- [12] Jiang, J., Liu, T., Zhang, Y., Song, Y., Zhou, M., Zheng, X., Yan, Z.: Design and development of an intelligent nursing bed - A pilot project of "joint assignment." *Proc. Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. EMBS.* 38–41 (2017). <https://doi.org/10.1109/EMBS.2017.8036757>.
- [13] Vijayan, J., Raju, G.: A New approach to Requirements Elicitation Using Paper Prototype. *Int. J. Adv. Sci. Technol.* 28, 9–16 (2011).