# Forecasting Maternal Satisfaction with the Quality of Pregnancy and Childbirth Services using the ANFIS Method

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Keywords: Quality of Service, Pregnancy, Childbirth, Maternal Satisfaction.

Abstract: The decrease in the number of patient visits to a hospital allegedly due to dissatisfaction because of the unexpected quality of service. The purpose of this study was to analyze the effect of the quality of pregnancy and childbirth services on maternal satisfaction. Evaluating and modeling variables on 18,782 respondents with 200 samples were conducted. Supporting analysis of the questionnaire data using univariate, bivariate with chi-square test, and multivariate with multiple logistic regression at the 95% confidence level ($\alpha = 0.05$) was chosen. The results of modeling using the Adaptive Neuro-Fuzzy Inference System (ANFIS) method showed satisfactory results with an accuracy of 92.3%. While statistically there was the influence of physical evidence, reliability, quick response, and empathy to patient satisfaction $p < 0.05$. The variable that had the greatest influence on maternal satisfaction was responsiveness with a good chance of 7.9 times higher toward the less good.

## 1 INTRODUCTION

The success of maternal health efforts can be seen from the indicators of Maternal Mortality Rate (MMR). This indicator is not only able to assess maternal health programs, moreover it is able to assess the degree of public health (because of its sensitivity to improving health services, both in terms of accessibility and quality) (Ministry of Health Republic of Indonesia, 2015). WHO defines maternal mortality as a death that accurs during pregnancy or within a period of 42 days after the pregnancy ends, which is caused by all caused to or aggravated bu pregnancy or its handling, but not due to accident/injuries (Askar, M. 2019). The 2012 IDHS is 359 maternal deaths per 100,000 live births. AKI again showed a decrease to 305 maternal deaths per 100,000 live births based on the 2015 Intercensal Population Survey (SUPAS) (BPS, 2015). This achievement is still far from the Sustainable Development Goals (SDGs) target in 2030, reducing maternal mortality to below 70 per 100,000 live births (Ministry of Health, 2017).

Most cases of maternal and perinatal mortality occur in women who do not receive antenatal care with more than 99% that women living in developing counties (Dauletyarova, M. A, 2018). Data from the North Sumatra Province Health Service shows that maternal deaths in 2016 were 175 cases. The maternal death was caused by eclampsia factors, such as seizures, edema or swelling of the body, the presence of kidney leakage and the most severe, namely hypertension totaling 38 people. Bleeding factors, such as maternal anemia 47 cases, infection 10 cases, parturition jams 3 cases, abortion 3 cases and others 70 cases. The highest number of maternal deaths in Deli Serdang Regency is 27 people, North Nias is 22 people, Asahan is 21 people. However, Labura and Nias have not received the data (Provincial Health Office, 2017).

AKI in North Sumatra reached 194 people in 2017. The number has decreased from 2016 which was 240 people. Although maternal mortality and infant mortality rates have declined, the health sector has SDGs indicators (Medan City Health Office, 2018). Based on the health profile of North Sumatra Province in 2016, the ratio of specialist doctors, including obstetric specialists to 100,000 residents was 19.80, while the ratio of midwives to 100,000 residents was 139.53. This shows that there is still a lack of specialist doctors and the distribution is also uneven in 33 districts / cities (Provincial Health Office, 2017).

Maternity period is important and crucial in the life of women. An array of services is provide to



Jelita, A., Girsang, E. and R. Nasution, S.
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DOI: 10.5220/0010291401330140
In *Proceedings of the International Conference on Health Informatics, Medical, Biological Engineering, and Pharmaceutical (HIMBEP 2020)*, pages 133-140
ISBN: 978-989-758-500-5

pregnant women during this period. These service include prenatal care and counselling, skilled delivery, assistance recourse to caesarean sections. Developing world have high risk of maternal mortality. 1 in 38 women as compared to 1 in 3700 women, leading to increased number of women seeking maternal helath (Konlan, K.D, 2018).

Lari and colleagues define that patient satisfaction as the extent of an individual's experience compared with her expectations or what patients' and the population need to receive from health care service. WHO encourages the presence of skilled doctors at each birth to reduce maternal mortality and recommends that women satisfaction be assessed to improve the effectiveness and quality of health care (sayed et al, 2018). Bramadat et all (in Ajayi, A. I, 2019) defined satisfaction a "positive feeling" or "effective response" to an event. Srivastava et al (in Ajayi, A. I, 2019) that women satisfaction with maternal health care services, three dimensions of care are structural, processes and outcomes. The structural includes good physical environment, cleanliness of wards, theatres and toilets and adequate human and material resouces. The process aspect relate to interpersonal and emotional support received from doctors or midwives, privacy and promptness. While the outcome aspect relate to connotes the health status of the mother and the baby.

Services for pregnant and childbirth women are carried out by health workers, professionally will be done as well as possible so that pregnant women feel satisfied with the services provided (Varney, 2015). Many factors can influence a person to feel satisfied with services in health facilities such as clinics, health centers, and hospitals such as the experience of midwives and doctors during the examination process, complete facilities, ease of location of health facilities that are easily accessible, competitive rates, speed Dauin conducting examinations friendliness of midwives and doctors in ANC and childbirth services (Baety, 2015).

Based on Amu, H & Nyarko, S.H (2019) research, a few issues were considered to asses maternal satisfaction with services provide. These included satisfaction with head-to-toe examination, health education, services relating to drugs and delivery serives. Accros the maternal healthcare continue, the assessment of maternal satisfaction has basically focused on physical environment, available of services, hygiene and accommodation conditions, interpersonal relationshipwith healthcare professional, the organization of work, and the competence and skilled of healthcare professional.

In terms of service, health workers will make the best effort in services such as increasing inspection facilities that do not yet exist, improving facilities such as waiting rooms, and parking spaces for visitors' vehicles, increasing the level of skills of health workers such as attending health training or seminars on ANC issues and childbirth (Spiritual, 2016; Turnip et al, 2020; Wijaya et al, 2019). Health facilities such as clinics, health centers, maternity hospitals, hospitals are required to be able to provide quality services that can meet the needs and desires of clients (Prawirohardjo, 2013). Health facilities can have better services than others, for example in terms of providing motivation to clients, hospitality services by providing smiles, greetings, and greetings, providing low prices, especially for the lower middle class. The quality of health services in good health facilities is maternity homes that are truly quality and able to compete (Barata, 2014).

Quality must start from the needs of the patient (client) and end on the perception of the patient (client). This means that a good quality image is not based on the viewpoint or perception of the service provider, but based on the viewpoint or perception of the patient (client). Zeithaml, Berry, and Parasuraman in Tjiptono stated that service quality consists of tangible, reliability, responsiveness, assurance, and empathy (Tjiptono & Chandra, 2015). Perception of quality maternity services differed significantly by the type of facility used by women. Based on Konlan K. D etal (2018) researchin Nepal, women considered the private hospital to provide quality meternity services due to the avaibility of amenities and equipment as well as good midwife-client relationship. In addition, attitudes and behaviors of maternal health care providers influence health care seeking and quality of care.

Mindaye & Taye's research in Addis Ababa, Ethiopia, concluded that from 406 research respondents that respondents were satisfied with laboratory services (physical / direct evidence) with an average of less than 30 minutes. Respondent satisfaction is more influenced by the complete facilities so as to facilitate service to patients (Mindaye & Taye, 2012). Hermanto's research examines Midwifery Inpatient at Dr. H. Soemarno Sosroatmodjo Bulungan East Kalimantan in 2010 found that the factors related to patient satisfaction were maternal perceptions of reliability, responsiveness, assurance, empathy, and direct evidence (Hermanto, 2010). Likewise Kahar's research at the Barru District Hospital in 2017 showed that there was an influence of reliability, responsiveness, assurance, empathy, and direct

evidence. Reliability variable is the most influential factor on inpatient satisfaction (Kahar, Palu, & Raodhah, 2017).

Getting good and proper quality health services were the desire of every individual who wants to do care and treatment. This concerns about individual satisfaction in receiving services through health facilities that aim to maintain and improve health and cure disease.

## 2 METHOD

Stella Maris Hospital in Medan is included in the category of special hospitals that provide services for maternal and child health problems, ranging from maternal, reproductive and children. Integrated services at the Stella Maris Mother and Child Hospital are carried out by a dedicated team of Obstetrics and Gynecology Specialists, Pediatricians, Neonatologists and nurses. Stella Maris Hospital provides high-quality health services for all matters related to fertility, pregnancy, menstrual problems, menopause, pelvic infections, cancer in women, and health care for infants, children and adults.

Based on interviews conducted by researchers in an initial survey of 15 visiting mothers, 9 people were satisfied with the services provided during pregnancy and childbirth. While 6 other people feel less satisfied with the quality of pregnancy and childbirth services. The dissatisfaction felt by the mother was related to the presence of some doctors and nurses who are not friendly, waiting in line for a long time due to the large number of patients that must be treated, communication with nurses was less intertwined, there were some nurses who less responsive when asked for help by patients, and lack of empathy.

This type of research was a quantitative analytic study with a cross sectional study design. The study population was 18,782 people, and samples were obtained about 200 respondents. The research sampling technique was accidental sampling. Univariate data analysis, bivariate using chi-square test, and multivariate using multiple logistic regression tests with a confidence level of 95% ($\alpha$ = 0.05).

Adaptive neuro fuzzy inference system (ANFIS) method is a method that uses artificial neural networks to implement fuzzy inference systems. The advantage of fuzzy inference systems is that they can translate knowledge from experts in the form of rules, but it usually takes a long time to determine the membership function. Therefore it takes learning techniques from artificial neural networks to automate the process so that it can reduce search time, this causes the ANFIS method to be very well applied in various fields (Turnip, 2018). Similar to artificial neural networks, there are also layers in ANFIS but the number is an average of five layers as shown in Figure 1. In general, the mathematical form of ANFIS is

IF x is A1 AND y is B1 THEN f1 = p1x + q1y + r1
IF x is A2 AND y is B2 THEN f2 = p2x + q2y + r2
dengan,

$$f = \frac{w_1 f_1 + w_2 f_2}{w_1 + w_2} = \overline{w}_1 + \overline{w}_2$$

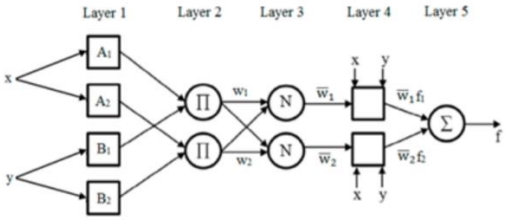


Figure 1: ANFIS processing scheme with input and output layers.

In the Figure 1, the first layer functions to convert crisp numbers into fuzzy numbers by using fuzzy sets. In the second layer, each input goes to the same layer to find out firing strength. In the third layer normalization calculations were carried out before applying to the fourth layer. Normalization was the process of re-weighting to obtain a total / max of one. On the fourth layer, the process was continued by multiplying with functions that involve inputs (x and y) to produce output that was already in the form of CRISP. The final step was to accumulate the results of the fourth layer (for the two rules). While for the learning method, backpropagation with the principle of minimizing errors that occur in the form of mean absolute percent error was used (Kusumandari et al, 2018; Turnip et al, 2018).

In this study, the independent variables in the form of appropriateness, change efficacy, management support, and personal fit are used as inputs and the independent variables in the form of accreditation sustainability as an output were used in the modeling using ANFIS method. About 40% of the measured data from queries are used as a data training and the last part were used for data testing.

## 3 RESULTS AND DISCUSSIONS

Characteristics of respondents involved in the study can be seen as in Table 1.

Table 1: Characteristics of Research Respondents.

| No | Characteristics | Respondents | |
|---|---|---|---|
| | | f | % |
| 1. | **Age (years):** | | |
| | a. <20 | 0 | 65,5 |
| | b. 20-35 | 131 | 34,5 |
| | c. ≥35 | 69 | |
| **Numbers** | | **200** | **100,0** |
| 2. | **Education :** | | |
| | a. Midble high school | 39 | 19,5 |
| | | 98 | 49,0 |
| | b. Diploma | 63 | 31,5 |
| | c. Undergraduate | | |
| **Numbers** | | **200** | **100,0** |
| 3. | **Occupation:** | | |
| | a. House wife | 91 | 45,5 |
| | b. Official staff | 25 | 12,5 |
| | c. Private employees | 15 | 7,5 |
| | | 69 | 34,5 |
| | d. Entrepreneurs / Traders | | |
| **Numbers** | | **200** | **100,0** |
| 4. | **Childbirth of:** | | |
| | a. First | 34 | 17,0 |
| | b. Second | 79 | 39,5 |
| | c. Third | 67 | 33,5 |
| | d. Fourth | 18 | 9,0 |
| | e. Fifth | 2 | 1,0 |
| **Jumlah** | | **200** | **100,0** |

Based on the results of the bivariate analysis, all independent variables were found to be significantly related to maternal satis faction. The complete Chi-Square statistical test results can be seen in Table 2.

Table 2: The Relationship of Each Independent and Dependent Variable.

| Variables | Mother's satisfaction | | Numbers | *p-value* |
|---|---|---|---|---|
| | Satisfy | LessStasisfy | | |
| | f | f | F | |
| Tangible: | | | | |
| Good | 125 | 11 | 136 | 0,000 |
| Less | 29 | 35 | 64 | |
| Reliability: | | | | |
| Good | 123 | 19 | 142 | 0,000 |
| Less | 31 | 27 | 58 | |
| Responsiveness: | | | | |
| Good | 138 | 18 | 156 | 0,000 |
| Less | 16 | 28 | 44 | |
| Assurance: | | | | |
| Good | 124 | 18 | 142 | 0,000 |
| Less | 30 | 28 | 58 | |
| Empathy: | | | | |
| Good | 129 | 14 | 143 | 0,000 |
| Less | 25 | 32 | 57 | |

The results of multivariate analysis with multiple logistic regression tests showed that from the five candidate model variables, four variables were found that affect maternal satisfaction, namely tangible, reliability, responsiveness, and empathy. The most influential variable was the responsiveness variable with the value Exp (B) / OR = 7.985 (Table 3), which means that mothers who expressed good hospital responsiveness, had the opportunity to feel satisfied with pregnancy and childbirth services by 7.9 times higher than those of not good.

Table 3: Multiple Logistic Regression Test Results.

| Variable | B | Sig. | Exp(B) | 95%CI for Exp(B) |
|---|---|---|---|---|
| Tangible | 2,028 | 0,000 | 7,598 | 2,919-19,782 |
| Reliability | 1,115 | 0,029 | 3,049 | 1,121-8,293 |
| Responsiveness | 2,078 | 0,000 | 7,985 | 2,902-21,976 |
| Empathy | 1,552 -10,52 | 0,002 | 4,719 | 1,799-12,373 |

## 3.1 Tangible Effect

Tangibles was the ability of a company to show its existence to external parties. The appearance of the office and employees, the ability of physical facilities and infrastructure, and the surrounding environment were tangible proof of the services provided by the service buyer. Appearance of services was not only limited to the physical appearance of a magnificent building but also the appearance of officers and the availability of supporting facilities and infrastructure. Tangible dimensions are the appearance and ability of reliable physical facilities and infrastructure. Tangible includes the comfort of inpatient rooms, environmental cleanliness, appearance of medical personnel, and completeness. The quality of a health service is closely related to the will in meeting the needs of the users of health services, the more perfect the fulfillment of these needs the better the quality of service.

Based on the results of multivariate analysis with the results of the study indicate that there is an influence of physical evidence (tangible) on maternal satisfaction, p = 0,000 <0.05. Variable physical evidence that has a value of Exp (B) / OR = 7.598 means that mothers who state good hospital physical evidence, have the opportunity to feel satisfied with pregnancy and childbirth services by 7.5 times higher than mothers who state that hospital tangibility is not good.

Based on the results of this study prove that tangibles significantly influence the satisfaction of mothers who receive pregnancy and childbirth services. Mothers who stated that the quality of services based on good physical evidence dimensions tended to feel satisfied, and conversely mothers who said that physical evidence was less good tended to feel dissatisfied.

It was assumed that the satisfaction felt by the mother as a respondent relates to a clean and

comfortable pregnancy and maternity examination room, equipment, clean and well-maintained bathroom. Likewise, the appearance of health workers (doctors, midwives, nurses) must be clean and neat. The things that are visible to the eye and can be assessed directly cause patients to be able to provide an assessment in accordance with what is perceived. If the physical evidence that was felt and seen exceeds what is expected then the patient will feel satisfied.

## 3.2 Reliability Effect

The perception of the reliability of midwifery services can be viewed from the ability of officers to provide services properly, such as the ability of doctors to diagnose illnesses, heal or hospital obligations, all hospitalized patients must be given medical care, nursing care or midwifery care regardless of the class of care. In general, midwifery inpatients stated that the reliability of inpatients was good. Respondents who stated that the reliability they received was good was due to a series of examinations the doctor was able to immediately know the patient's illness and they were given drugs and injections according to schedule.

Based on the results of the study indicate that there was an effect of reliability on maternal satisfaction, p = 0.029 <0.05. The reliability variable has a value of Exp (B) / OR = 3.049, which means that patients who state good hospital reliability, have the opportunity to feel satisfied with pregnancy and childbirth services by 3 times higher which was not good. The results of this study prove that reliability in pregnancy and childbirth services has a significant effect on patient satisfaction.

Reliability was assumed to be related to officers providing information about the results of pregnancy examinations and childbirth actions and routinely receive doctor and midwife/nurse service visits. Health workers must answer all patient complaints about pregnancy and childbirth and explain the results of the examination that has been done. Reliability is also related to the actions taken by health workers in conducting a thorough examination. The reliability of health workers is an important concern in the quality of pregnancy and childbirth services so that patients become more confident.

## 3.3 Responsiveness Effects

Responsiveness was one of the determining factors in the progress of a hospital. Satisfaction was a condition when the needs, desires, and expectations of patients can be met through the consumed products / services. The quality of health services is generally associated with satisfaction of health services. Based on the results of the study showed that there was an effect of responsiveness on patient satisfaction, p = 0,000 <0.05. The responsiveness variable has a value of Exp (B) / OR = 7.985 which means that patients who state that the hospital's responsiveness was good, have a 7.9% higher chance of being satisfied with pregnancy and childbirth services.

The results of this study indicate that responsiveness in pregnancy and childbirth services has a significant effect on satisfaction. Responsiveness was assumed in increasing patient satisfaction related to the readiness of health workers to come immediately if called and asked for help. Health workers also routinely carry out checks and respond to complaints felt by patients. The responsiveness of health workers was also related to examinations carried out according to schedule so that patients are not aware of the conditions they are experiencing. In this study shows that responsiveness was the variable that has the biggest effect on patient satisfaction.

## 3.4 Empathy Effects

Based on the results of the study showed that there was an empathy effect on patient satisfaction, p = 0.002 <0.05. The empathy variable (empathy) which has a value of Exp (B) / OR = 4,719 means that patients who state that the hospital empathy was good, have the opportunity to feel satisfied with pregnancy and childbirth services by 4.7 times higher than the less good ones.

Indicators of patient satisfaction in hospitals can be applied by improving service management so that patient satisfaction can be realized such as empathy or attention from health workers. In addition, the quality of empathy dimensions of service can be a factor in choosing a quality hospital. The empathy service variables measured included nurses serving regardless of social status, providing guidance about illness and its prevention, communicating with patients well, introducing themselves to patients and giving attention. Responsiveness is one factor the results of this study prove that the quality of service in the empathy dimension significantly influences patient satisfaction in pregnancy and childbirth services.

Empathy can be done by getting patients to communicate effectively about the conditions of pregnancy and childbirth. Hospitality and courtesy in dealing with patients are also evaluated where health workers must be friendly and polite. Health workers

must also provide opportunities for patients to express health problems they face, and express feelings during pregnancy, childbirth and also after childbirth. All of that was delivered in language that is easily understood by patients so that they feel satisfied and also states that the quality of service was on the empathy dimension.

Stages of the implementation of the Adaptive Neuro-Fuzzy Inference System method in forecasting maternal satisfaction based on the quality of pregnancy and childbirth services is making a flowchart design, conducting data clustering using fuzzy C-Mean, determining the neurontiap of each layer, looking for parameter values using recursive LSE, then determining error calculation using a sum square error and deciding on a model of forecasting maternal satisfaction.

After the system was designed and used as a system of forecasting maternal satisfaction with the quality of pregnancy and childbirth services, the system's accuracy level must be tested. In this study, the involved 200 respondents' data from questionnaires, where 2/3 of the overall data is used as training data (150 data). The first step when running a program for forecasting maternal satisfaction is to enter data (150 training data) into the training form as shown in Figure 2 (a) input the required values that include tangible data, reliability, responsiveness and target output in the form of maternal satisfaction and then continue filling training data Figure 2 (b). Training data here was class, maximum epoh, error, learning rate and momentum. Training data for class was 5, maximum epoh was 40, error tolerance was 10-6 (Fig. 3 (a), learning rate was 0.9 and momentum 0.6. By using hybrid learning methods, ANFIS can map input values towards output values based on knowledge which is trained in the form of fuzzy rules.

Figure 3 (b) shows how the relationship of 150 data checking taken randomly from 200 data, with FIS output was ANFIS learning outcomes from 150 training data. It can be seen that from the 100th data up to 145 data distributions began to spread and differs from the first 150 which tend to be converging. This was because ANFIS has never recognize the provided so it makes the accuracy in ANFIS method decrease. After updating the rules about 1024 which the variables are interconnected, the prediction model design was obtained as shown in Figure 4. Figure 4 above is also called ANFIS Architecture which consists of 5 input variables, each of which has 4 classes and the rightmost layer is the output in the form of maternal satisfaction. Membership function for input variables as a combination of membership functions was triangular representation (trimf). Fig.5 is a comparison between satisfaction output measured from the questionnaire towards ANFIS learning with accuracy level of 97.48%. Those accuracy level indicates that the designed predictive model could predict the mather's satisfication level with an error value of 0.0251.

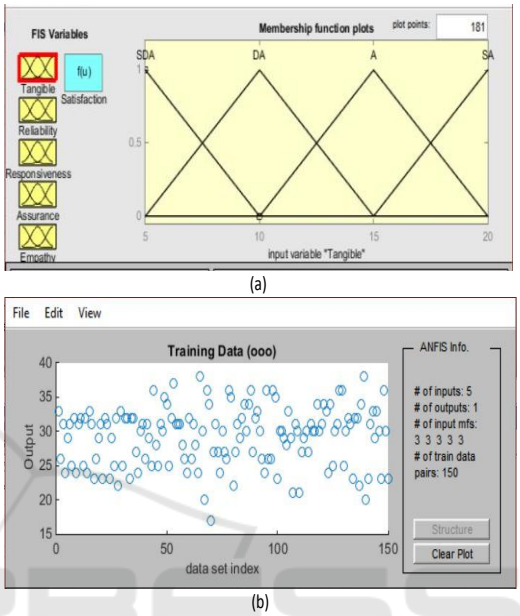


Figure 2: (a) Membership function and (b) Training data.

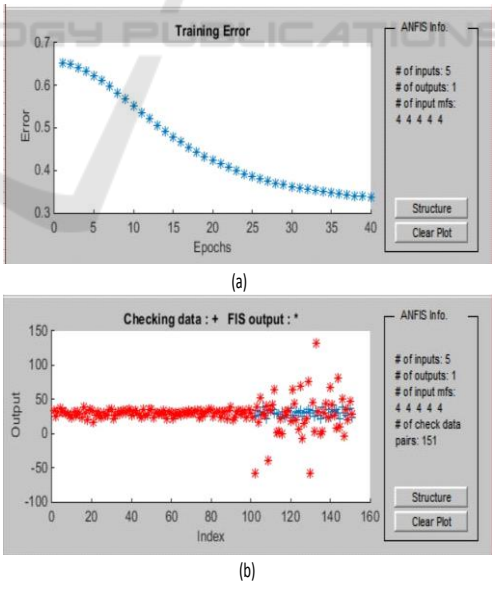


Figure 3: (a) Taining error about 10-6 and (b) Checking data: FIS output.

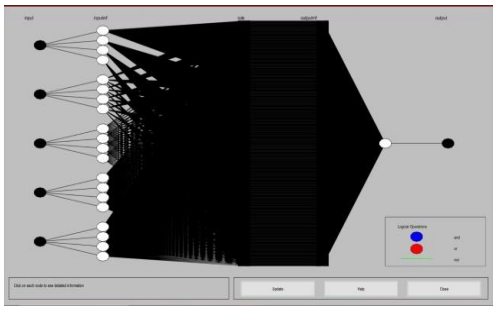

Figure 4: (a) Deigned Model ANFIS for Mother' s Satisfication prediction.

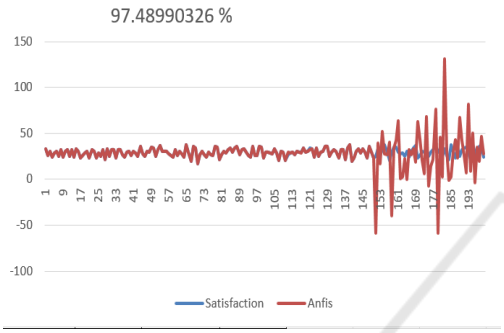


Figure 5: (a) Classification accuracy about 97.48%.

## 4 CONCLUSIONS

Physical evidence, reliability, responsiveness, and empathy affect patient satisfaction, while the guarantee variable has no effect. The most influential variable in this study is the responsiveness variable which has a value of Exp (B) / OR = 7.985, which means that patients who state good hospital responsiveness, have the opportunity to feel satisfied with pregnancy and childbirth services by 7.9 times higher than the less well.

After conducting an experiment by entering the class variable is 5, the maximum epoh is 400, error is 10-6, the range of learning rate values is 0.6 to 0.9, and the range of values of momentum = 0.6 to 0.9. The results that showed the smallest SSE were learning rate 0.9 and momentum 0.6 with SSE 0.0251. The accuracy of the results of forecasting maternal satisfaction with the ANFIS method is 97.48% with a relatively small error. These results indicate that the design of a predictive model can be used to predict the level of satisfaction of mothers giving birth at a hospital based on quality criteria for pregnancy and childbirth services.

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