# Prediction of the Effect of Specialist Services on Patient Satisfaction using the SVM Method

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Abstract:    The availability of specialist doctors is absolutely necessary for curative services in hospitals because professional services are at the core of patient satisfaction. The existence of patient complaints about the services of specialist doctors has an impact on patients dissatisfaction. The purpose of this study is to develop a model that is able to predict the effect of the quality of specialist services on patient satisfaction based on previous services. For development and testing, patients with a population of 750 respondents with 88 samples were used. Modeling was built using the support vector machine method. For weighting the model, the study data using univariate, bivariate with chi-square test, and multivariate with multiple logistic regression at a 95% confidence level ($\alpha = 0.05$) were used. The results showed that the accuracy of the built model by 91.7% was achieved, where there was an effect of reliability, responsiveness, and assurance on inpatient satisfaction $p < 0.05$. While the tangible and empathy variables have no significant effect. The variable that had the greatest influence on patient satisfaction was assurance with a 9.5 times higher chance of poor specialist medical guarantees.

## 1 INTRODUCTION

The hospital is a health service institution for the community with its own characteristics that are influenced by the development of health science, technological advancements, and the socio-economic life of the community (Bustami, 2015). Hospitals cannot be released from the burden of responsibility to provide quality services for patients (Azwar, 2016).

Hospitals require the presence of doctors to carry out their functions as a health service organization. Doctors as professionals need a container that is able to accommodate and facilitate medical technical work through the provision of teams, equipment, and various other supporting needs (Herlambang, 2016). The availability of specialist doctors is absolutely necessary for curative services in hospitals because professional services of specialist doctors are at the core of hospital services (Scholten & Grinten, 2015).

Patient satisfaction will be fulfilled if the doctor's professional behavior in providing health services is as expected by the patient or family. Stages of specialist doctors providing health services include history, physical examination, therapy, and termination (E. Gusti, 2016). Specialists in providing health services that are friendly, comfortable, caring

and able to accommodate the needs of patients are demands that must be met by the hospital. Even though in reality, the implementation of health services is still oriented towards the interests of providers rather than the interests of patients and the community. The research of Murtiana E et al found that there was a relationship between the quality of administrative services, doctors, nurses, quality of facilities and infrastructure, and hospital environment to patient satisfaction with a value of $p = 0.00 < 0.05$ (Murtiana, 2016) . Outpatient medical facilities as one of the busiest in Malaysia found that the highest patient satisfaction is in the service factor or direct evidence priority, especially technical quality, accessibility, and comfort but that satisfaction is low in terms of doctors service orientation, especially time spent with doctors, interpersonal behavior, and communication during consultations (Ganasegeran, 2015).

The number of patients continues to increase at each health care institution, while the number of specialist doctors is not proportional to the number of existing patients (Vonikartika et al., 2018). Based on data from the Indonesian Medical Consul (KKI) that the total number of doctors is 217,749 people, consisting of 141,230 general practitioners, 32,757

dentists, 39,646 specialist doctors, 4,116 specialist dentists (Indonesian Medical Council, 2019). The ratio of the number of specialist doctors in Indonesia has not met the target, from 14.6 per 100,000 the population has only been realized 10 per 100,000 (Ministry of Health, Republic of Indonesia, 2018).

Based on data from the North Sumatra Provincial Health Office that the number of specialist doctors in the whole area of North Sumatra Province was 654 people, out of 913 health facilities available. The highest number of specialist doctors was in Medan City with 373 people, followed by Deli Serdang District with 78 people, Binjai City with 35 people (Provincial Health Office, 2018).

The disproportionate number of doctors, especially specialist doctors, causes doctors who provide services to tend to be a bit slow and sometimes less reliable, less responsive, less convincing, show less concern in carrying out their duties, even though every patient who comes to the hospital would want a fast and appropriate service . In the service process the factor of concern for patients cannot be ignored by specialist doctors so that patients feel satisfied with the services provided (Vonikartika et al., 2018).

Patient satisfaction is a major factor and is a measure of success as a result of services provided to customers that impact the number of patient visits increases, and patients who are satisfied with the service tend to return (Tjiptono & Chandra, 2015). Patient satisfaction will have a direct effect on company profits so health care providers are required to improve overall performance which will have a positive impact on patient satisfaction. Patient satisfaction cannot be underestimated, if health care providers can satisfy their patients, it will be a big advantage for these health care providers (Khunwuthikorn, 2011; Turnip et al, 2020; Wijaya et al, 2019). A good understanding from every hospital officer such as a specialist about patient satisfaction so that specialist doctors will provide the best service and provide satisfaction to the patients they serve (Haffizurrachman, 2014).

Low quality will cause dissatisfaction with patients, not only patients at the clinic but also have an impact on others. Because patients who are disappointed will tell others (Lupiyoadi & Hamdani, 2016). Furthermore, Parasuraman, Berry, & Zeithaml (1991) identified a gap between patients and health service providers which resulted in the failure to deliver quality services. Health care providers do not always understand exactly what the patient wants.

Mardiana Research (2012), respondents who were satisfied with the services of specialists in internal medicine at the outpatient installation of the Friendship Hospital were respondents who were old, female, married, not employees, high school education, long time visitors, short waiting times and long checks by a doctor. Overall, the level of satisfaction of respondents to the quality of services specialist in internal medicine is still very low. Indratno's research (2017) at the Graha Amanah Specialist Clinic in Klaten found that: reliability, responsiveness, assurance, empathy, tangibility had a positive and significant effect on patient satisfaction with the services of specialist doctors. Purba research (2015) at H. Adam Malik General Hospital Medan got the result that the patient's evaluation of the health services of specialist doctors with quite satisfied criteria (54.2%). There is a relationship between specialist doctor professional services (competence and service) with general patient satisfaction (p <0.05).

Regarding patient satisfaction with the services of specialist doctors, researchers conducted a preliminary survey by interviewing 10 patients who received specialist doctor services. As many as 5 people expressed satisfaction with the service during treatment, as many as 2 people felt quite satisfied, and as many as 3 people said they were not satisfied. Patients who are satisfied, explain that the disease information in accordance with its capabilities, not angry if the patient asks a lot. Whereas patients who are dissatisfied because they consider specialist doctors less friendly or less communicative, lack detail in responding to perceived complaints, waiting in line for long, doctors are not in accordance with the practice schedule. This is consistent with the data obtained from the suggestion box.

## 2 METHOD

This type of research is a quantitative analytic study with a cross sectional study design. This study was conducted at Stella Maris Hospital in Medan in December 2019. The study population was the total number of patient visits to specialist doctors as many as 750 visits, and samples were obtained as many as 88 people. The research sampling technique was done by simple random sampling. Figure 1 explains the questionnaire design scheme as a measurement instrument. Validity test was conducted at Sarah Medan General Hospital for 30 patients. The test conducted was to determine the correlation between the questions with the total construct score or variable. A construct is declared valid if there is a positive and significant correlation. The correlation

value must be greater than 0.361 or the Corrected Indicator-Total Correlation value in the SPSS output greater than 0.361 using the Pearson Product Moment correlation test (Ghozali, 2015). Univariate data analysis, bivariate using chi-square test, and multivariate using multiple logistic regression tests with a confidence level of 95% ($\alpha = 0.05$).
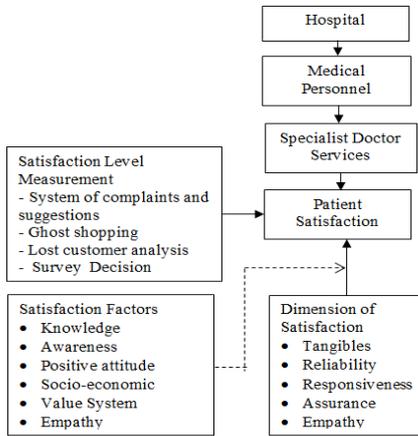


Figure 1: Research Scheme

Support Vector Machine (SVM) is a classification method that works by defining the boundary between two classes with the maximum distance from the closest data (Clarke, 2009; Turnip, 2018). To get the maximum limit between classes, a hyperplane must be formed in the best input space obtained by measuring the margins and finding the maximum point. Margin is the distance between the hyperplane and the closest point of each class. This closest point is called the support vector (Campbell, Ying, 2011; Kusumandari et al, 2018; Turnip et al, 2018). The solid line in Figure 2 shows the best hyperplane, which is located right in the middle of the two classes, while the red and yellow dots in the black circle are support vectors. The effort to find the location of a hyperplane is the core of the learning process in SVM.

The available data is denoted as $\vec{x}_i \in \Re^d$ while the respective label is represented by $y_i \in \{-1, +1\}$ for $i = 1, 2, ..., l$, which $l$ is the amount of data. It is assumed that the two classes of -1 and +1 can be completely separated by hyperplane with dimension of $d$, defined as

$$\vec{w}.\vec{x} + b = 0 \tag{1}$$

Patterns $\vec{x}_i$ that belong to a class -1 (negative sample) can be formulated as a pattern which fulfill the inequality

$$\vec{w}.\vec{x}_i + b \leq -1 \tag{2}$$

While the pattern $\vec{x}_i$ is included in the class +1

$$\vec{w}.\vec{x}_i + b \geq +1 \tag{3}$$

The largest margin can be found by maximizing the value of the distance between the hyperplane and its closest point, that is $1/\|\vec{w}\|$. This can be formulated as a Quadratic Programming problem, which is finding the minimum point of equation (4), taking into account the constraints of equation (5).

$$\min_{\vec{w}} \tau(w) = \frac{1}{2}\|\vec{w}\|^2 \tag{4}$$

$$y_i(\vec{x}_i.\vec{w} + b) - 1 \geq 0, \quad \forall i \tag{5}$$

This problem can be solved by various computational techniques, including Lagrange Multiplier.

$$L(\vec{w}, b, \alpha) = \frac{1}{1}\|\vec{w}\|^2 - \sum_{i=1}^{l} \alpha_i(y_i((\vec{x}_i.\vec{w} + b) - 1)) \tag{6}$$

$\alpha_i$ is Lagrange multipliers, which are zero or positive $(\alpha_i > 0)$. The optimal value of equation (6) can be calculated by minimizing $L$ with respect to $\vec{w}$ and $b$, and maximize $L$ against $\alpha_i$. Due to the nature by considering the optimal point of gradient $L = 0$, the equation can be modified as the maximization of problems that only contain $\alpha_i$, as in equation (7) below

Maximize:

$$\sum_{i=1}^{l} \alpha_i - \frac{1}{2}\sum_{i,j=1}^{l} \alpha_i \alpha_j y_i y_j \vec{x}_i \vec{x}_j \tag{7}$$

subject to:

$$\alpha_i \geq 0 \ (i = 1, 2, ..., l) \quad \sum_{i=1}^{l} \alpha_i y_i = 0 \tag{8}$$

From the calculation, the value of $\alpha_i$ is obtained which mostly positive. The positive data that correlated with $\alpha_i$ is called as support vector.
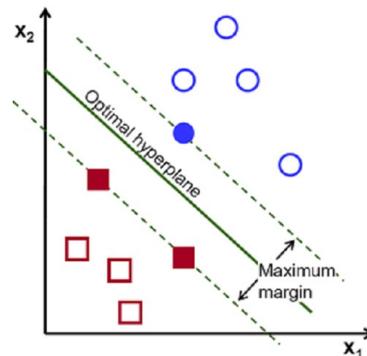
Figure 2: SVM to get the best hyperplane that separates two data classes.

## 3 RESULTS AND DISCUSSION

Characteristics of respondents ie most respondents aged ≥45 years (52.3%), a small proportion aged <45 years (47.7%). Based on gender, all respondents were female (100.0%). Based on education, the majority of respondents had a diploma education (59.1%), a small proportion had a high school education (6.8%). Based on work, most respondents were housewives (31.8%), a small proportion of respondents worked as civil servants (12.5%). Based on the length of stay, most had 2 days 1 night (53.4%), a small portion had been 5 days 4 nights (2.3%).

Based on the results of bivariate analysis, all independent variables were found to be significantly related to inpatient satisfaction (p = 0,000). The complete Chi-Square statistical test results can be seen in Table 1.

Table 1: Relationship of Each Independent and Dependent Variable.

| Variables | Satisfaction | | Total | p-value |
| | Satisfied | Less | | |
| | f | f | F | |
|---|---|---|---|---|
| Tangible: Good | 63 | 8 | 71 | |
| Less | 8 | 9 | 17 | 0,000 |
| Reliability: Good | 64 | 5 | 69 | |
| Less | 7 | 12 | 19 | 0,000 |
| Responsiveness: Good | | | | |
| Less | 63 | 4 | 67 | 0,000 |
| | 8 | 13 | 21 | |
| Assurance: Good | | | | |
| Less | 64 | 6 | 70 | |
| | 7 | 11 | 18 | 0,000 |
| Empathy: Good | 65 | 8 | 73 | |
| Less | 6 | 9 | 15 | 0,000 |

The results of multivariate analysis with multiple logistic regression tests showed that of the five variables as model candidates, three variables were obtained that affected inpatient satisfaction, namely reliability, responsiveness, and assurance. The most influential variable in this study is the assurance variable which has the value of Exp (B) / OR = 9.525 meaning that patients who claim a good specialist

doctor's guarantee have the opportunity to feel satisfied with their services 9.5 times higher for the less good.

Table 3: Multiple Logistic Regression Test Results.

| Variables | B | Sig. | Exp(B) | 95%CI for Exp(B) |
|---|---|---|---|---|
| Reliability | 2,066 | 0,016 | 7,894 | 1,478-42,162 |
| Assurance | 1,852 | 0,028 | 6,371 | 1,225-33,138 |
| Constant | 2,254 | 0,006 | 9,525 | 1,924-47,147 |
| | -9,912 | 0,000 | | |

### 3.1 Reliability Effects

Based on the results of the study indicate that there was an effect of reliability on inpatient satisfaction. Patients who claim specialist doctors are reliable, have the opportunity to feel satisfied with their services by 7.8 times higher than patients who claim specialist doctors are less reliable. The relationship between patient perceptions of medical technical skills and the interest in patient visits was found. The less good the patient's perception of medical technical skills, the less interested the patient's return is.

The availability of specialist doctors was absolutely necessary for curative services in hospitals. Without specialist services, the existence of hospitals as health care institutions is meaningless. Reliable specialist doctors become an indicator of the quality of services available in hospitals that will satisfy the patients being served (Scholten & Grinten, 2016). This is in accordance with the opinion of Bowers Bowers, Swan, & Koehler (2017), in looking at the quality of health services mentioned factors that determine the quality of service, namely reliability, ability, skills and knowledge of officers must be in accordance with service providers and doctors who are trained with well.

The results of this study prove that the reliability of specialist doctors has a significant effect on patient satisfaction. It is assumed that patients who claim that reliable specialists tend to be more satisfied than patients who say less reliable. The reliability of specialist doctors felt by patients, namely specialist doctors being professional in providing services to patients and families. Specialists also regularly check the patient's condition on schedule. In conducting examinations, specialists do it carefully so that patients feel satisfied with the results of the examination. Not only conducting examinations, specialist doctors are also required to provide counseling or health education to patients in accordance with the patient's illness and how to treat it. Specialists must use language that is easily understood by patients so that patients can receive

information with enthusiasm and can be applied in prevention and treatment.

## 3.2 Responsiveness Effects

The effect of rapid response was found to inpatient satisfaction. Patients who stated that specialist doctors were responsive were more likely to be satisfied with their services by 6.3 times higher than patients who stated that specialist doctors were less responsive.

The quality of health services for patients is seen more in several aspects ranging from the responsiveness of officers in meeting patient needs, responding to patient complaints, respect, the smooth communication of officers with patients, and the hospitality of officers in serving patients. To find out whether these aspects are working well or not, an evaluation is needed. Satisfaction is a feeling of pleasure or disappointment someone after comparing the perception of the performance or results of a product with expected. The higher level of hospital competition will cause patients to face more alternative choices, prices and varying quality, so patients will always look for the value that is considered the highest of several products. For this reason, the responsiveness of health workers needs to be improved so that patients feel satisfied with the services provided.

This study proves that the responsiveness of specialist doctors has a significant effect on patient satisfaction. Most respondents stated that specialist doctors conducted examinations and actions with responsiveness and they were satisfied while respondents who stated that specialist doctors were less responsive tended to be less satisfied.

According to the researchers' assumptions, their satisfaction was related to specialist doctors who came according to the specified schedule and took immediate action. In addition specialist doctors must demonstrate readiness to help if requested by patients. Patients get an explanation of the treatment through counseling related to the illness experienced. The most important thing is the specialist doctor explains to the patient and family in detail about the patient's medicines, how to take them, and how to maintain the patient's body condition so that they do not experience things that can aggravate the disease. The speed and reliability of specialist doctors in providing services to patients makes patients feel satisfied (patients get services beyond expectations).

## 3.3 Assurance Effects

Based on the results of the study showed that there was a guarantee effect on inpatient satisfaction. Patients who stated that the specialist doctor's guarantee was good, had the opportunity to feel satisfied with the service by 9.5 times higher than patients who stated that the specialist's doctor's guarantee was not good.

One of the main ways to differentiate health services including outpatient services is to provide quality health services, consistently higher than competitors. The key is to meet or exceed patient expectations about the quality of the service it receives. After receiving health services, patients will compare the services they experience with the expected services. If the services experienced are below the expected service, the patient is no longer interested in returning.

The results of this study prove that the quality of specialist services on the assurance dimension significantly influences patient satisfaction. Patients who state that a good specialist is guaranteed tend to be satisfied with the services provided and conversely patients who say they are not good tend to be less satisfied.

According to the researchers' assumptions, the satisfaction felt by patients that specialist doctors can answer questions raised by patients and families. The answers given make the patient better understand about his illness and foster confidence in providing services. The specialist doctor shows his skills in providing information about the actions taken. In addition, specialist doctors are also able to provide a sense of security so that patients are confident that their illness will recover after receiving service. Specialists must be able to instill trust in patients to cure the illness.

## 3.4 Prediction with SVM

Hospital satisfaction dataset consisting of six variables is not easy to make in the graph for predictive analysis in its original form because the six coordinates (of features) of the dataset cannot be mapped onto a two-dimensional screen. Therefore the data dimension must be reduced by applying the dimension reduction algorithm to the feature. Figure 3 is the plot spread - visualization of the points plotted representing the observations on the graph. This distribution plot represents the known results from 88 training datasets. The figure shows the plot of the Support Vector Machine model that is trained with a dataset which is dimensionally reduced to two features. Five features are a set of small features that are stored. This plot covers the decision surface for

classifiers - the area in the graph that represents the decision function used by SVM to determine the results of new data inputs. The lines separate the area where the model will predict the particular class of data points that are owned. From this plot it can be clearly seen that the class cannot be separated by a two-dimensional cra so it must be done in three dimensions as in Figure 4.
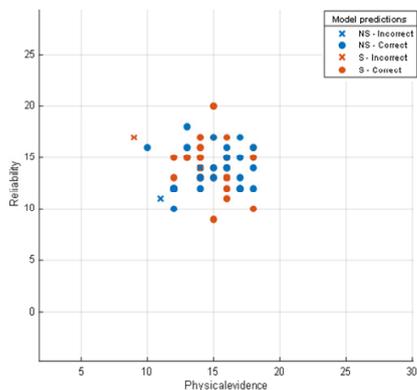


Figure 3: Spread - visualization of the points plotted representing the observations.
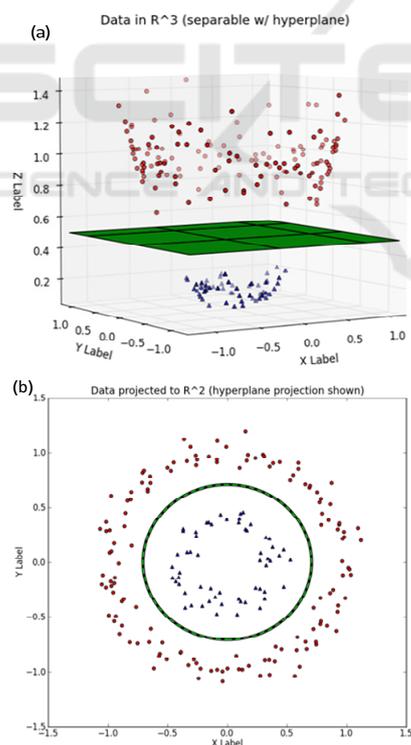


Figure 4: 3D hyperplane (b) Hyperplane projection in 2D.

The SVM was used to find the best hyperplane by maximizing the distance between classes. Hyperplane is a function that can be used for separating between classes. Its position is in the middle between the two classes, meaning that the distance between the hyperplane and the data objects is different from the adjacent class (the outer) which is given a blank and positive round mark. In SVM the outermost data object that is closest to the hyperplane is called a support vector. Objects called support vectors are the most difficult to classify due to positions that almost overlap with other classes. Given its critical nature, only this support vector is calculated to find the most optimal hyperplane by SVM.

In the Number of observation as in Figure 5, we can see Incorrect data in orange, and correct data in blue. So it can be concluded that the more blue the data means the possibility of Incorrect data getting smaller and vice versa. Confusion matrix (Figure 6) understands how the current classification is chosen to help identify areas where the classification of bad and good performance. The row shows the correct class while the column shows the predicted class. If the classification is blue, then the classification of observations is calculated correctly and if the classification is orange, the classification level is calculated incorrectly. Positive predictive values are shown in blue for points that were predicted correctly in each class, and incorrect discovery rates are displayed in orange for incorrect prediction points in each class. In Figure 6 we can see the percent of data that has been classified Correct and Incorrect. The concept is the same as in Figure 5 except for Positive Pradict Value (PPV) & False Discovery Rates (FDR). TPR and FNR are the data conclusions that have been classified, what percentage of all variables have Correct and Incorrect data. TPR is the proportion of observations classified correctly per class True while the FNR is the proportion of observations classified incorrectly per true class. The plot shows the summary per class correctly in the last two columns on the right. If false positives are important in classification problems, plot results per class are predicted (not true class) to investigate the extent of false discoveries. To see the results per prediction class, under Plot, select the Positive Predictive Value (PPV) option, False Discovery Value (FDR). These results indicate that a prediction accuracy of 91.7% is achieved.
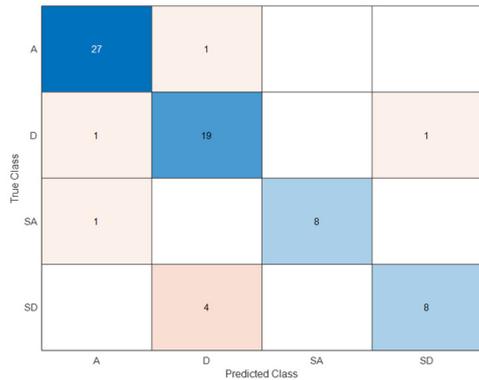
Figure 5: Number of Observation.

These results are in line with the results found in Figure 7 which shows the relationship between the independent variables and the dependent variables. Parallel Coordinats Plot serves to see the relationship between variables. And see which relationships have correct and Incorrect.
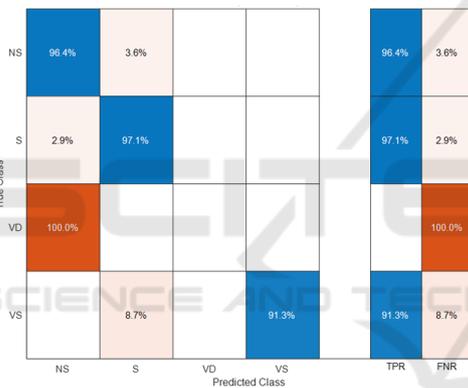


Figure 6: Confusion matrix
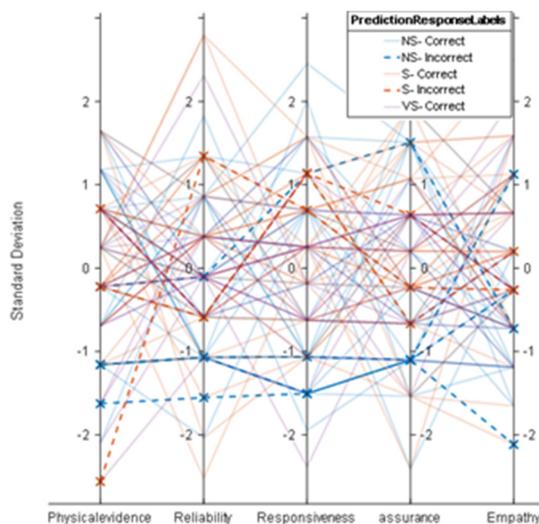


Figure 7: Parallel Coordinates Plot.

# 4 CONCLUSIONS

Reliability, responsiveness, and assurance variables of specialist doctors have affect on patient satisfaction, while variables of tangible and empathy have no effect on inpatient satisfaction. The variable that had the greatest influence on patient satisfaction was assurance with a 9.5 times higher chance of poor specialist medical guarantees. The prediction of the effect of specialist services on patient satisfaction using the SVM method with accuracy of 91.75 is achieved.

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