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Decision Support System Implementation of Decision Tree Algorithm C4.5 In Employee Performance Assessment

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Abstract

Employee performance assessment can be used as an evaluation tool to improve employee performance and achieve more. Performance appraisal's benefits include improving business quality, driving business progress, and improving employee welfare. Yasmin Medical Clinic requires an employee performance appraisal system to help superiors process data properly to shorten the time and produce an assessment based on the subjective value of decision-making. One method that can be used in a decision support system is a decision tree. Current decision trees, such as C4.5 and CART, are widely used in various fields. The analysis results show that applying the decision support system of the decision tree algorithm c4.5 in employee performance appraisal can solve problems at the Yasmin Medical Clinic. A computerized decision support system helps decision-making and produces objective decisions based on actual conditions.

Keywords: *Employee Performance Assessment; Decision Support System; C4.5 Algorithm*

Abstrak

Penilaian kinerja karyawan dapat digunakan sebagai alat evaluasi untuk meningkatkan kinerja karyawan agar semakin berprestasi. Beberapa manfaat dari penilaian kinerja yakni seperti meningkatkan kualitas bisnis, mendorong kemajuan bisnis, dan meningkatkan kesejahteraan karyawan. Klinik Yasmin Medical membutuhkan sistem penilaian kinerja karyawan yang dapat membantu atasan untuk mengolah data dengan baik sehingga dapat mempersingkat waktu serta menghasilkan penilaian yang sesuai dengan nilai subjektivitas pengambilan keputusan. Salah satu metode yang dapat dipakai dalam sistem pendukung keputusan adalah adalah pohon keputusan (*decision tree)*. Pohon keputusan saat ini seperti C4.5 dan CART banyak digunakan di berbagai bidang. Hasil analisis menunjukkan bahwa penerapan sistem pendukung keputusan implementasi *decision tree algoritma* c4.5 dalam penilaian kinerja karyawan mampu menyelesaikan masalah di Klinik Yasmin Medical. Sistem pendukung keputusan yang terkomputerisasi membantu proses pengambilan keputusan dan menghasilkan keputusan yang objektif yang sesuai dengan kondisi sebenarnya.

Kata-kata kunci: *Penilaian Kinerja Karyawan; Sistem Pendukung Keputusan; Algoritma C4.5*

1. Introduction

Rapid technological advances in the current era are the main driving force behind innovations that improve effectiveness and efficiency in various fields. The implications of this progress extend to the medical field, especially clinics and hospitals. Healthcare facilities in Indonesia offer quality health management services that utilize computer-based information systems to support change and improvement in all fields by competing with each other. These services include facilities and infrastructure, including finance, medical equipment, logistics, and human resources.

Yasmin Medical Clinic is a clinic that serves patients with impaired kidney function to undergo dialysis (Hemodialysis) outside the hospital on an outpatient basis. The clinic on Jalan Besar Bahapal Sumber Sari was just established in 2021. Yasmin Medical Clinic has a vision and mission to become a leading hemodialysis service center that provides high-quality care with a holistic, innovative approach and is based on patient welfare. Assessing an employee's professionalism to determine how much employee performance has improved is one of the agendas to improve the implementation of employee performance. The problem at the Yasmin Medical Clinic is the unavailability of a system for processing efficient performance assessment data. Yasmin Medical Clinic requires an employee performance appraisal system that can help superiors process data properly to shorten and produce assessments based on the subjective value of decision-making. Employee performance assessments can be used as evaluation material to improve performance and produce high-achieving employees **[1]**. Performance appraisal has various beneficial impacts besides improving employee performance standards. These impacts include improving quality, encouraging company development, and improving employee welfare **[2]**.

A decision support system (DSS) is a computer-based information system that uses data analysis and related information to assist decision-makers in solving specific unstructured management challenges **[3] [4] [5] [6]**. DSS is often created to help identify opportunities or solve problems **[7] [8]**. One method that can be used in a decision support system is a decision tree **[9]**. A technique based on discrete-valued approximation functions is the decision tree method **[10]**. Nowadays, decision trees such as C4.5 and CART are widely used in various fields due to their simplicity, accuracy, and intuitive interpretation **[11] [12] [13]**. This method has a tree-like structure that represents decisions on each branch and is taken based on relevant conditions **[14]**. The topmost attribute is called a leaf, representing the class **[15] [16]**. Decision trees effectively

break down complex decision-making processes into more straightforward judgments to reach a solution close to the desired outcome **[17], [18]**.

The research was previously conducted by Untung Surapati and Arif Prasetyo with the title Application of the C4.5 Algorithm in Determining the Best Employees at the Hosana Clinic, West Jakarta **[19]**, in previous research conducted by M. Fajar Ikhsan and Siti Nurmiati with the title Design of Web-Based Employee Performance Assessment Using the Rating Scale Method **[20]**.

The difference between previous research and this research lies in the results. Previous research only shows how to calculate entropy and gain values. In addition, the resulting system has unclear performance standards. This study tested samples based on specific criteria or attributes, so a third calculation using the decision tree method was no longer needed.

This study aims to build a computerized decision support system that can help the performance assessment process at the Yasmin Medical Clinic. The creation of this system is expected to help performance assessments improve the quality of clinic services and improve employee quality with the right decisions.

2. Method

Data collection is an essential component of research. This is done so that the data collected properly can produce a quality system or program **[21]**. This study uses several stages, namely the data collection stage with qualitative methods and the waterfall method as a system developer. Qualitative methods are data collection methods that involve observation, interviews, and literature reviews taken from books, journals, and articles **[22]**. Software development using the waterfall method is done in a very methodical and sequential manner. Starting from the level of system progress, this model method offers an accurate and methodical approach to software development that covers all aspects of analysis, design, coding, testing, and maintenance [23], [24]**.** The research flowchart contains the steps taken during the research presented in **Figure 1**.

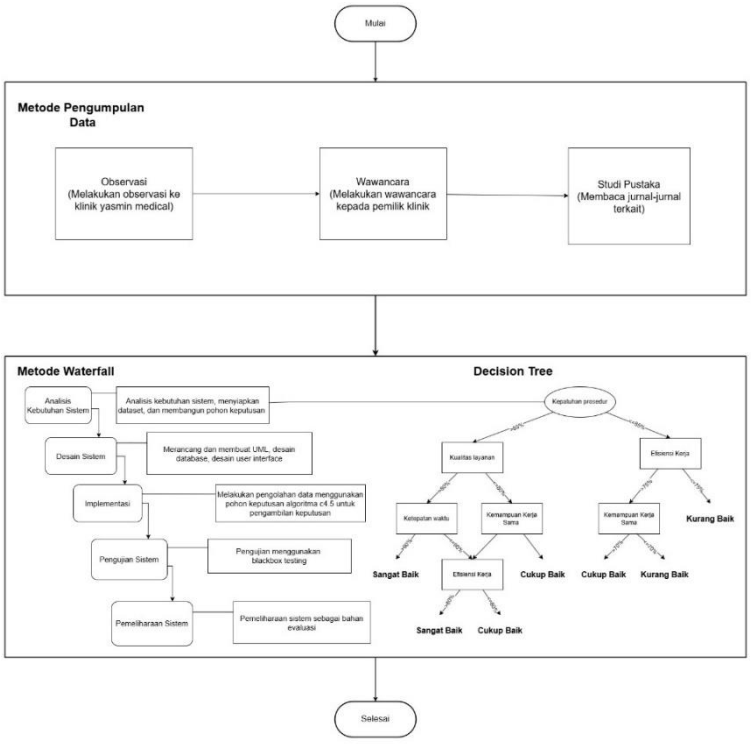

Figure 1. Research Method

2.1 Observation

Observation is research conducted by conducting an in-depth analysis of a particular condition. Observation is the first method of data collection carried out **[25]**. Researchers conducted observations at the Yasmin Medical Clinic on Jalan Besar Bahapal Sumber Sari, Dolok Batu Nanggar District, Simalungun Regency, North Sumatra Province, to collect data and information related to clinic problems.

2.2 Interview

Question and answer sessions between researchers and resource persons are used as a data collection method in interviews to gain an understanding of the issues being researched **[26]**. The researcher conducted a direct interview with Mr. Eko Prismando, the director of the Yasmin Medical Clinic, to collect information on the criteria the Clinic needs to support the results of employee performance assessments and the user needs of the system to be developed.

2.3 Literatur Riview

Conducting a literature study by referring to relevant literature, journals and previous research[27]The author searches and reads various books, e-books, journals, and previous research. The data collected from this literature review is used to complete the research framework and serves as a reference.

2.4 System Requirements Analysis

System requirements analysis is carried out at this stage to ensure user needs and the running system. In addition, preparing datasets and building decision trees. After building a decision tree, the rules used to make a decision are obtained with several determinants or attributes, namely procedural compliance, service quality, timeliness, cooperation ability and work efficiency.

2.5 System Design

Conducting system design design using UML (Unified Modeling Language) diagrams that can be built using use case diagrams. Design includes actors, relationships, use case diagrams and activity diagrams.

2.6 Implementation

After conducting the design stage, the researcher performs data processing based on the decision tree model obtained to obtain a match for the analysis conducted. In this case, the focus is on creating a program for its use.

2.7 System Testing

Conducting a thorough testing of the developed system to ensure that all features run as expected and there are no errors or bugs. Testing is done through BlackBox Testing.

2.8 Maintenance

The system maintenance stage is very important because it affects the entire information system development process carried out and can ensure that the resulting system can run well and meet user needs for a long period.

3. Results and Discussion

3.1 Results

3.1.1 System Requirements Analysis

Based on the analysis conducted, problems were found in determining employee performance assessments, where there were no rules and no system for efficiently conducting them. In determining performance assessments, employee data and several criteria were required, which were obtained from the interviews with Mr. Eko Prismando, the director of the Yasmin Medical Clinic. Employee data is presented in **Table 1**.

Table 1. Employee Data

No	Name	Position	Gender	Age
1	Indah Purnama Sari A.Md.T	Secretary	Female	23 Years
2	Budiati A.Md	Treasurer	Female	46 Years
3	dr. Bayu, Sp.PD.KGH	Supervisor	Male	39 Years
4	dr. Titik Larasati, Sp.PD	Doctor in Charge	Female	61 Years
5	dr. Merry Hutagalung	Emergency Doctor	Female	53 Years
6	dr. Leonardus Mirzal Lumban Gaol	Implementing Doctor	Male	53 Years
7	Dedi Afriawan, Apt	Pharmacy Responsible	Male	41 Years
8	Riza Nadila S.Farm	Pharmacist Assistant	Female	23 Years
9	Putri Ayu Lestari A.Md.Kep	Nurse	Female	23 Years
10	Try Wanda Lestary A.Md.Kep	Nurse	Female	22 Years
11	Rika Sundari A.Md.Kep	Nurse	Female	27 Years
12	Cindy Lestary A.Md.Kep	Nurse	Female	23 Years
13	Nur Fauziah Simamora S.Kep, Ns	Nurse	Female	23 Years
14	Rahma Raya Ulfah Damanik A.Md.Kep	Nurse	Female	31 Years
15	Dina Aulia S.Kep.Ns	Nurse	Female	23 Years
16	Venta Richa Seroja A.Md.Kep	Nurse	Female	23 Years
17	Dinda Azhari	Nurse	Female	21 Years
18	Silvita Mandayana	Administration	Female	22 Years
19	Fahrian Nur Ananda	Security	Male	23 Years
20	Rahmatsyah	Technician	Male	46 Years
21	Andika Putra	Driver	Male	23 Years

Determining the attribute data of the decision tree is the initial stage that will later produce decisions in assessing employee performance. Attribute data and assessment weights are presented in **Table 2.**

Table 2. Attribute Data

No	Attribute Data	Weight Of Assessment
1	Procedural Compliance	Very Poor (1-25) Poor (25-50) Good Enough (50-75) Very Good (75-100)
2	Quality Of Service	Very Poor (1-25) Poor (25-50) Good Enough (50-75) Very Good (75-100)
3	Punctuality	Very Poor (1-25) Poor (25-50) Good Enough (50-75) Very Good (75-100)
4	Cooperation Skills	Very Poor (1-25) Poor (25-50) Good Enough (50-75) Very Good (75-100)
5	Work Efficiency	Very Poor (1-25) Poor (25-50) Good Enough (50-75) Very Good (75-100)

Building a decision tree to determine whether employees are among the high-performing employees at Yasmin Medical Clinic. The decision tree is presented in **Figure 2.**

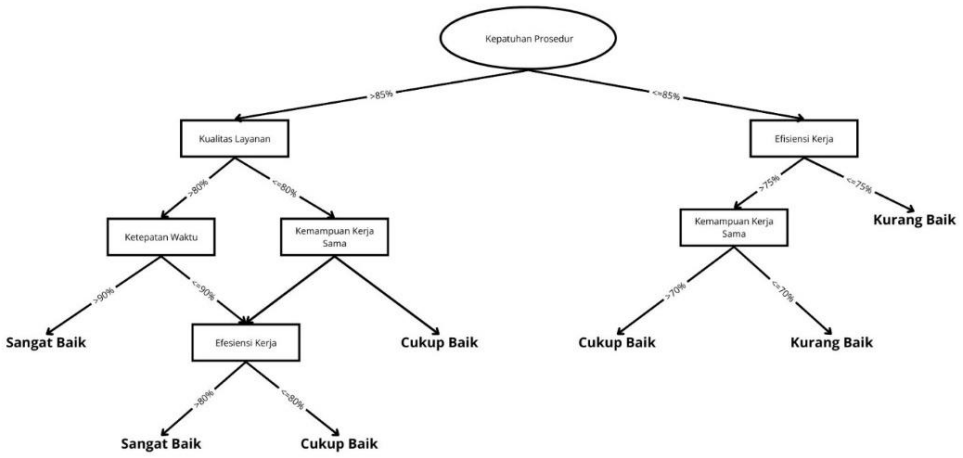

Figure 2. Decision Tree

The IF-THEN logic states that if a condition is met, then a consequence will occur. In determining the decisions of high-performing employees, the IF-THEN logic is based on the decision tree presented in Table 3.

Table 3. IF THEN Logic

IF Kepatuhan Prosedur **≥ 85%:**
IF Kualitas Layanan **> 80%:**
IF Ketepatan Waktu **> 90%:, THEN Sangat Baik**
IF Ketepatan Waktu **≤ 90%:**
IF Efisiensi Kerja **> 80%, THEN Sangat Baik**
IF Ketepatan Waktu **≤ 80%, THEN Cukup Baik**
IF Kualitas Layanan **≤ 80%:**
IF Kemampuan Kerja Sama **> 90%, THEN Cukup Baik**
IF Kemampuan Kerja Sama **≤ 90%, THEN Kurang Baik**
IF Kepatuhan Prosedur **< 85%:**
IF Efisiensi Kerja **> 75%:**
IF Kemampuan Kerja Sama **> 70%, THEN Cukup Baik**
IF Kemampuan Kerja Sama **≤ 70%, THEN Kurang Baik**
IF Efisiensi Kerja **≤ 75%, THEN Kurang Baik**

Create an assessment table based on attribute data and the assessment weight of each employee that has been obtained. The performance assessment is presented in **Table 4.**

Table 4. The Performance Assessment

No	Name	Procedural Compliance	Quality Of Service	Punctuality	Cooperation Skills	Work Efficiency	Evaluation
1	Indah Purnama Sari A.Md.T	90%	80%	80%	80%	90%	Good Enough
2	Budiati A.Md	90%	90%	95%	90%	90%	Very Good
3	dr. Bayu, Sp.PD.KGH	80%	90%	50%	70%	60%	Poor
4	dr. Titik Larasati, Sp.PD	90%	80%	70%	80%	80%	Good Enough
5	dr. Merry Hutagalung	90%	80%	50%	80%	70%	Good Enough
6	dr. Leonardus Mirzal Lumban Gaol	90%	80%	60%	80%	70%	Good Enough
7	Dedi Afriawan, Apt	80%	80%	60%	70%	70%	Poor
8	Riza Nadila S.Farm	80%	90%	90%	70%	90%	Poor
9	Putri Ayu Lestari A.Md.Kep	50%	70%	50%	40%	50%	Poor
10	Try Wanda Lestary A.Md.Kep	90%	80%	80%	80%	70%	Good Enough
11	Rika Sundari A.Md.Kep	90%	80%	80%	80%	70%	Good Enough
12	Cindy Lestary A.Md.Kep	70%	70%	90%	90%	50%	Poor
13	Nur Fauziah Simamora S.Kep, Ns	90%	90%	80%	80%	90%	Good Enough
14	Rahma Raya Ulfah Damanik A.Md.Kep	70%	80%	60%	79%	80%	Poor
15	Dina Aulia S.Kep.Ns	70%	80%	70%	89%	79%	Poor
16	Venta Richa Seroja A.Md.Kep	80%	90%	90%	80%	88%	Poor
17	Dinda Azhari	90%	90%	85%	80%	80%	Good Enough

18	Silvita Mandayana	90%	90%	80%	90%	90%	Very Good
19	Fahrian Nur Ananda	90%	80%	70%	80%	80%	Very Poor
20	Rahmatsyah	50%	40%	50%	50%	45%	Poor
21	Andika Putra	50%	70%	80%	80%	70%	Poor

3.1.2 System Design

Use Case is a diagram that describes the features in a system and explains the characteristics of the system from the user's perspective[28]The system has two users, admin and superior. **Figure 3** presents a use case diagram.

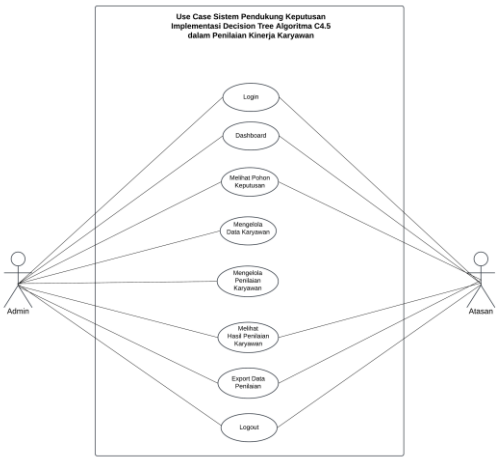

Figure 3. Use Case

3.1.3 Implementation

a. Dashboard

The dashboard page displays the system's overall features, such as the total number of employees, which is the number of all employees at the Yasmin Medical Clinic. Then there is the total assessment this month, the total best employees this month, and the last assessment that is input into the system. The dashboard is presented in **Figure 4.**

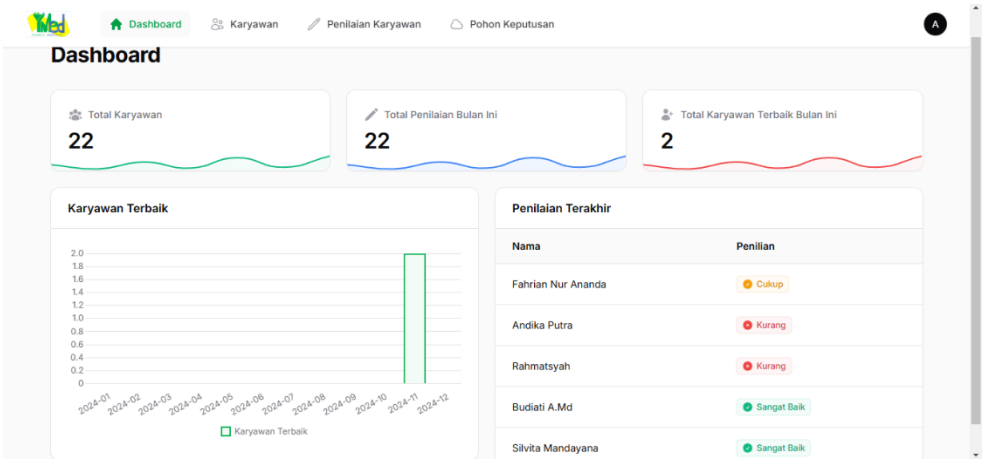

Figure 4. Dashboard

b. Decision Tree

The decision tree page displays the decision tree results created with five attribute data: procedure compliance, service quality, timeliness, cooperation ability, and work efficiency based on established rules. The decision tree is presented in **Figure 5.**

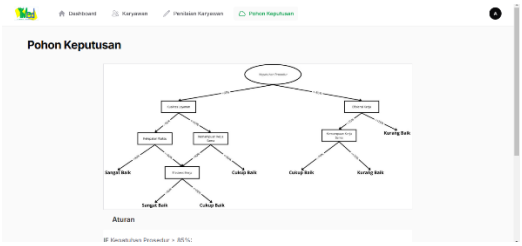

Figure 5. Decision Tree

c. Employee Data

This page displays employee data that has been input. Employee data can be added according to the amount you want to add. Employee data can be changed if there is an error when inputting. Employee data can also be deleted. Employee data is presented in Figure 6.

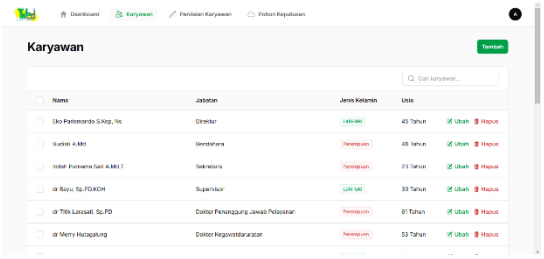

Figure 6. Employee Data

d. Employee Assessment Data

This page displays employee assessment data. Employee assessment data can be exported every month as a performance assessment report. Assessment data can also be added if employees have not been included in the assessment. If there is an error in inputting, assessment data can be changed and resubmitted. Employee assessment data is presented in **Figure 7.**

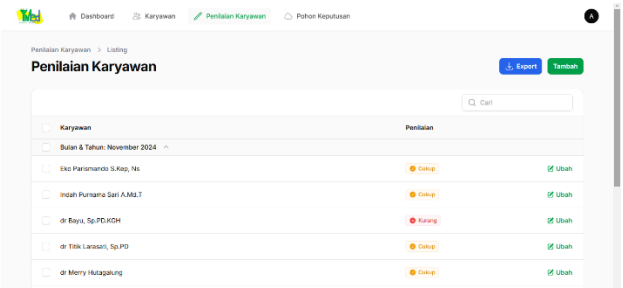

Figure 7. Employee Assessment Data

3.1.4 Black Box Testing

Black Box testing is testing an application to ensure that it functions properly. This method tests software without the need to examine or understand its internal details [29]. Black Box Testing is presented in Table 5.

Table 5. Black Box Test Results

Application Name : Decision Support System Implementation Of Decision Tree Algorithm C4.5 in Employee Performance Assessment				
No	**Testing**	**Test Description**	**Expected Result**	**Status**
1	Admin Login	Admin Login using e-mail and password	Admin successfully logged in and entered the dashboard page	Valid
2	Atasan Login	Atasan Login using e-mail and password	Atasan successfully logged in and entered the dashboard page	Valid
3	Dashboard	View the overall system view of total employees, total assessment this month, total best employees this month	Displays the entire system, namely total employees, total assessment this month, total best employees this month.	Valid
4	Decision Tree	Viewing the decision tree	Displaying a decision tree	Valid
5	Employee Data	Managing Employee Data	Employee data was successfully added, deleted and changed.	Valid
6	Employee Assessment Data	Managing Employee Assessment Data	Assessment data successfully added and changed	Valid
7	Employee Assessment Results	View employee assessment results	Showing the best employee assessment results	Valid
8	Export Assessment Data	View the results of exporting assessment data	Displays data export results for this month	Valid

3.2 Discussion

Previous research with the same method was conducted by Destia Lorinda and Wahyu Saputro with the title Classification of Decision Support Systems for Selecting the Best Employees Using the C4.5 Algorithm Method (Case Study: Subdit 1 Dit Tipidum Bareskrim Polri Jakarta)[30]. In the research conducted by Destia et al., only entropy and gain values were produced which were the raw results of the processed data. This is a shortcoming of the research because it was not implemented into a system so it cannot prove whether the assessment results are accurate.

The testing of the system that has been built using Laravel 11 as a framework with HTML and PHP programming languages and MySQL has been completed. This test ensures that the

system functions as designed and detect possible errors. The Decision Support System test results based on the Decision Tree Algorithm C4.5 in this study proved satisfactory. The features displayed function well and can help produce decisions. Therefore, the features that have been successfully developed are an advantage in this study compared to previous studies, most of which were not implemented in a system.

4. Conclusion

Based on the research that has been conducted, the best employee assessment results were obtained by Budiati and Silvita Mandayana with very good employee assessment results. With an average attribute value of 90, the system automatically classifies the employee into the best employee. So it can be concluded that applying the Decision Support System Implementation of the Decision Tree Algorithm C4.5 in Employee Performance Assessment can solve problems at the Yasmin Medical Clinic. If a computerized decision support system supports the decision-making process, it will produce objective decisions and by actual conditions. This decision support system is designed using a model that considers various factors as assessment criteria, and provides value weights based on these criteria. This system is expected to support performance assessments, improve the quality of clinic services, and improve employee quality through proper decision making.

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