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Application Of Decision Trees For Predicting High-Risk Pregnancies At The Sukarame Community Health Center

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ABSTRACT

High-risk pregnancy remains one of the major causes of maternal and infant morbidity and mortality, particularly in developing countries. Early identification of pregnancy risks at the primary healthcare level is essential to improve maternal healthcare services and reduce pregnancy complications. However, at the Sukarame Community Health Center, the identification of high-risk pregnancies is still conducted manually and relies heavily on subjective assessment by healthcare workers. Although medical record data of pregnant women are available, the data have not been optimally utilized for systematic risk prediction and classification. This study aims to implement the Decision Tree algorithm to predict high-risk pregnancies using medical record data from pregnant women at the Sukarame Community Health Center. The study applies a quantitative approach using secondary data consisting of maternal age, blood pressure, hemoglobin levels, pregnancy history, and clinical symptoms. The research process includes data collection, preprocessing, classification modeling using the Decision Tree algorithm, and evaluation of model performance using accuracy, precision, and recall metrics. The results indicate that the Decision Tree algorithm is capable of classifying pregnancy risks into low, moderate, and high-risk categories in a structured and objective manner. The resulting model generates interpretable decision rules that can assist healthcare workers in conducting early detection and intervention for high-risk pregnancies. Furthermore, the implementation of the web-based prediction system improves efficiency in processing patient data and reduces subjectivity in pregnancy risk assessment. Therefore, the proposed system can support data-driven decision-making and contribute to improving the quality of maternal healthcare services at the primary healthcare level.

INTRODUCTION

At the national and global levels, attention to maternal health is growing because pregnancy complications remain a major cause of significant maternal morbidity and mortality (Muningsih et al., 2023). Several studies indicate that despite various interventions, the decline in maternal mortality rates in developing countries has not shown sufficient improvement, making the detection and prediction of pregnancy risks a critical aspect of maternal health strategies (Khoiriyah & Ambarwati, 2024). This situation has driven the use of data-driven analytical technologies, including machine learning, to improve the effectiveness of pregnancy screening (Ridwansyah et al., 2022). In the context of primary care, such as community health centers, risk prediction methods are becoming increasingly relevant because these facilities serve as the initial point of contact for pregnant women with the healthcare system (Arfan & Paraga, 2024).

A common issue in many community health centers is that available data on pregnant women is often used only for routine reporting and administrative monitoring, but has not yet been optimally utilized for systematic risk prediction (Fadhil et al., 2025). Clinical and demographic data such as blood pressure, blood sugar, maternal age, and history of pregnancy complications are usually recorded, but the use of advanced analytics to identify risk patterns is not yet common practice (Sulistiani et al., 2025). Consequently, understanding of high-risk maternal groups remains reactive and is not always supported by structured classification models at the primary care level (Homepage et al., 2025). The impact of suboptimal early identification of pregnancy risks is significant for mothers, infants, and the healthcare system. High-risk mothers who are not detected in the early stages have a greater potential for complications such as preeclampsia, postpartum hemorrhage, preterm birth, and even maternal or infant mortality (Alawiyah et al., 2025).

Although numerous studies have explored machine learning in the context of high-risk pregnancies, there remains a significant research gap, particularly in primary care settings such as community health centers (Rahmawati et al., 2025). Most studies use complex algorithms or data from referral hospitals with substantial resources, whereas

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research applying easily interpretable algorithms such as Decision Trees in community health centers is scarce (Wibowo & Aryanti, 2025). This indicates an opportunity to implement simple and interpretable models that can be used by non-technical health workers in community health centers (Iin, 2025).

The urgency of this research is also very high, given that community health centers (puskesmas) are at the forefront of maternal care in Indonesia and possess fairly comprehensive data on pregnant women, yet this data has not been fully utilized for risk prediction. By applying a Decision Tree algorithm to the data on pregnant women at the Sukarame Community Health Center, the facility can gain an objective tool to classify pregnant women into risk categories (low, moderate, high) based on relevant variables. It is hoped that this application will improve early screening and targeted interventions at the primary level, which are crucial for enhancing the quality of maternal health care (Susilo et al., 2024).

The proposed methodology is a quantitative approach using an observational survey design based on secondary data obtained from the medical records of pregnant women at the Sukarame Community Health Center. The data will be processed through pre-processing steps such as data cleaning, variable transformation, and normalization, followed by the application of a Decision Tree algorithm for pregnancy risk classification. The analysis will continue with an evaluation of model performance using statistical metrics such as accuracy, precision, recall, and descriptive analysis of characteristics across risk groups. The study results are expected to provide appropriate recommendations for healthcare workers in the screening and intervention of high-risk pregnancies. Therefore, the objective of this study is to apply the Decision Tree algorithm to classify pregnancy risk levels into low, moderate, and high categories. To identify pregnancy risk factors that significantly influence the classification of high-risk pregnant women based on the Decision Tree model (Adelina Bui & Bahtiar, 2024).

LITERATURE REVIEW

Several previous studies have applied machine learning methods to support classification and prediction processes in the healthcare sector, particularly in pregnancy risk analysis. (Ridwansyah et al., 2022) implemented a combination of K-Means and Decision Tree methods to predict infant mortality and found that classification techniques were effective in identifying high-risk groups based on health indicators. Similarly, (Muningsih et al., 2023) demonstrated that the Decision Tree algorithm provides good classification performance because of its ability to generate interpretable decision rules that are easy to understand by non-technical users.

In another study, (Khoiriyah & Ambarwati, 2024) compared several classification approaches and concluded that Decision Tree methods are highly suitable for datasets requiring transparent decision-making processes. The study also emphasized that Decision Trees can simplify the interpretation of medical data and support healthcare workers in making decisions more objectively. Furthermore, (Arfan & Paraga, 2024) compared Decision Tree with other prediction algorithms and reported that Decision Tree offers advantages in terms of interpretability, classification speed, and ease of implementation.

Previous studies indicate that the Decision Tree method is effective for classification problems in various domains, including healthcare prediction systems. However, most existing studies focus on large-scale healthcare institutions or general medical datasets, while research specifically applying Decision Trees to predict high-risk pregnancies at the community health center level remains limited. Therefore, this study aims to implement a Decision Tree-based prediction system using pregnant women's medical record data at the Sukarame Community Health Center to support early detection of high-risk pregnancies in a more objective and systematic manner.

METHOD

This study applies a quantitative research approach to develop a prediction system for identifying high-risk pregnancies using the Decision Tree algorithm. The research process involves several stages, including data collection, data preprocessing, model development, system implementation, and evaluation. Medical record data of pregnant women obtained from the Sukarame Community Health Center are used as the primary dataset in this study.

The proposed method aims to classify pregnancy conditions into several risk categories based on maternal health indicators and clinical data. In addition, a web-based system is developed to facilitate healthcare workers in performing early prediction and monitoring of pregnancy risks. The research stages carried out in this study are illustrated in Figure 1.

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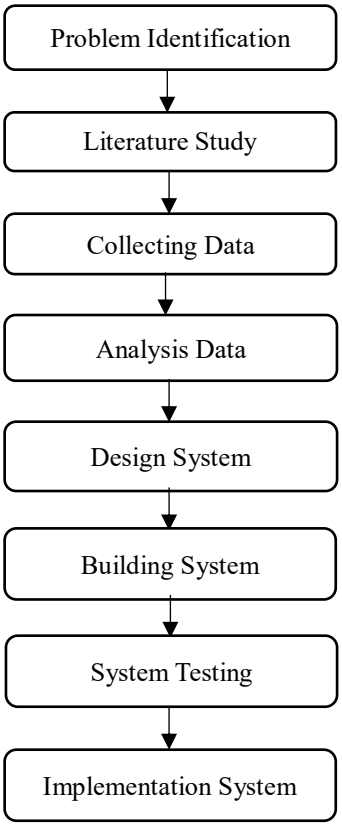


Figure 1. Research Stages

This research has the following stages:

Problem Identification

The problem was identified to understand the actual conditions surrounding the pregnancy risk assessment process at the Sukarame Community Health Center. To date, risk category determination has been heavily influenced by subjective manual judgments, often leading to inaccuracies in identifying pregnant women who should be prioritized for monitoring. This situation results in suboptimal care and inadequate detection of potential risks. Therefore, problem identification serves as a crucial foundation for implementing more objective and systematic prediction methods, such as a Decision Tree.

Literature Study

A literature review was conducted to establish a strong theoretical foundation for this study. This involved examining the concept of pregnancy risk, various medical factors that influence risk levels in pregnant women, and theories related to classification algorithms, particularly Decision Trees. The researcher also reviewed previous studies that utilized Decision Trees in the health field, particularly those focused on predicting pregnancy outcomes and analyzing medical data . In addition, literature on the use of the CodeIgniter framework in application development was also studied as a reference in the system implementation process. This literature review ensures that the research has a relevant scientific basis and supports the objective of predicting high-risk pregnancies at the Sukarame Community Health Center.

Collecting Data

Data collection was conducted to obtain the information needed for the process of building a Decision Tree model. The data collected included various attributes related to the condition of pregnant women, such as age, blood pressure, hemoglobin levels, medical history, body mass index, history of previous pregnancies, and other relevant medical examination results. In addition, risk label data including low, moderate, and high risk was also collected as a reference for the classification process. This information was obtained through direct observation at the Sukarame Community Health Center, interviews with midwives and health workers, and data extraction from the medical records of pregnant women. All of this data served as the primary basis for the training process and the creation of a predictive model using the Decision Tree algorithm.

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Analysis Data

At this stage, the researchers processed the collected data to build a classification model using the Decision Tree algorithm. The process began with data cleaning and preprocessing, such as handling missing values, standardizing data formats, and selecting the most relevant attributes related to pregnancy risks. Next, the Decision Tree model is trained by calculating the information gain or Gini index to determine the best attributes as decision-making criteria at each node of the decision tree. The resulting model is then tested to ensure that the generated classification patterns are accurate and capable of consistently predicting risk levels. The results of the validated decision tree are subsequently used as the basis for the system to automatically provide pregnancy risk predictions.

Design System

During the system design phase, the researchers began developing a design for the pregnancy risk prediction application to be created. The design was carried out using the CodeIgniter framework, implementing the Model-View-Controller (MVC) architecture to separate process logic, presentation, and data processing. Various design diagrams, such as use case diagrams, activity diagrams, sequence diagrams, and class diagrams, were created to illustrate the system workflow, the prediction process, and the relationships between application components (Fazira & Risawandi, 2025). Additionally, the database was designed using MySQL, encompassing tables for pregnant women's data, examination data, risk parameters, Decision Tree classification results, and prediction history. This design serves as the primary foundation for developing a structured and easily implementable system.

Building System

The system was developed based on the results of a needs analysis and the design that had been prepared earlier. At this stage, the system was developed by implementing the Decision Tree method to process pregnancy data, such as the mother's age, blood pressure, medical history, and health examination results. The system development process included user interface development, database management, and coding of classification logic to generate predictions of pregnancy risk levels. The system is expected to assist healthcare professionals in detecting high-risk pregnancies earlier and more accurately (Bili et al., 2024).

System Testing

System testing was conducted to ensure that every function within the application operates in accordance with its intended purpose. At this stage, black-box testing was used to assess whether features such as data entry for pregnant women, the classification process using a decision tree, and the presentation of prediction results function correctly. Additionally, a User Acceptance Test (UAT) was conducted with healthcare workers at the Sukarame Community Health Center to assess the application's ease of use and the accuracy of the displayed results. The accuracy of the Decision Tree model was also re-evaluated to ensure that the predictions provided by the system are fully aligned with the principles and calculations of the algorithm.

Implementation System

The system was implemented based on a previously developed design. The application was developed using CodeIgniter 4 and the PHP programming language. At this stage, several key modules were developed, including a data input module for pregnant women, a medical examination management module, a classification process using a Decision Tree algorithm, a risk prediction results display, and a reporting module for presenting final information. The system is run on a local server such as XAMPP or Laragon to ensure that all functions operate stably and the application can be used optimally.

RESULT

Analysis Data

Data requirements analysis for a pregnancy risk prediction system for patients using a decision tree algorithm based on Hb levels, history of miscarriage, interval between pregnancies, blood pressure history, age, parity, and reported symptoms. The following is the training data used for pregnancy risk prediction.

Table 1. Data Training

No	Name	Age	Medical History	Hb	Pregnancy	Symtoms
1	D**i	30	121/81	8,5	1	Heartburn
2	Ko***ia	31	130/80	12	2	Excess weight
3	E*i Su***ni	35	115/70	10,6	2	Back pain during the third trimester
4	Su****wati	42	134/81	11	4	Change in fetal position
5	S*i U**a	25	121/75	10,5	1	Decreased fetal movement
6	N** S*a*it*i	22	122/81	11,5	1	Premature labor
7	Ra*si*	36	124/82	11,8	3	Severe swelling of the legs
8	Sa**	32	118/70	13,1	2	Back pain during the third trimester

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9	S***n	19	128/75	9	1	Brown spotting
10	S***ni	38	121/81	10	3	Leaking amniotic fluid
…	…….	…	…	…	…	…
50	Pu*** Su***t*	24	100,7	12,5	1	One-sided abdominal pain

System Design

A Use Case Diagram is used to illustrate the relationships between actors and the system to be developed. Figure 1 shows an overview of the system design.

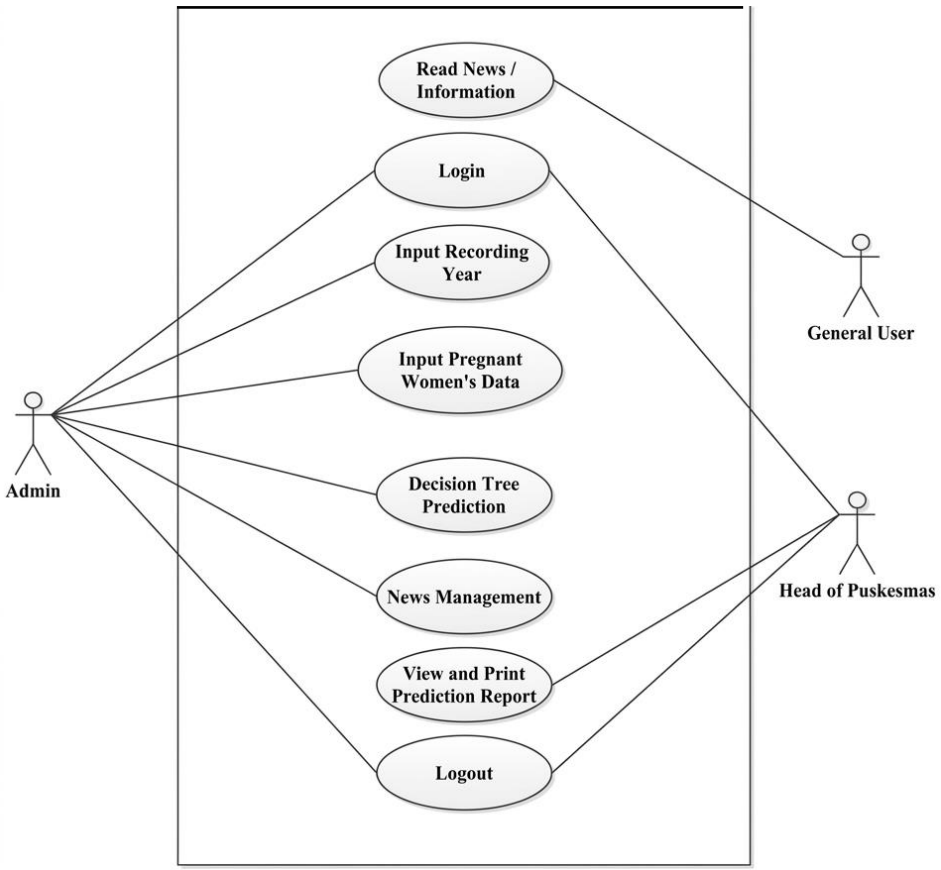


Figure 2. Use Case Diagram

Figure 1 illustrates the overall framework of the proposed high-risk pregnancy prediction system. The system begins with the collection of pregnant women's medical record data obtained from the Sukarame Community Health Center. The collected data include several important attributes such as maternal age, blood pressure, hemoglobin levels, pregnancy history, and clinical symptoms related to pregnancy conditions.

After the data collection process, the data are preprocessed to ensure completeness and consistency before being analyzed using the Decision Tree algorithm. The algorithm processes the training data to generate classification rules that can categorize pregnancy conditions into low-risk, moderate-risk, and high-risk groups.

The figure also shows the interaction between users and the web-based system, where healthcare workers can input patient data and obtain prediction results automatically. The prediction results are then used to support early detection and decision-making in handling high-risk pregnancies. This framework enables a more structured, objective, and efficient prediction process compared to conventional manual assessment methods.

Implementation System

The implementation phase is used to describe the interface of the system to be developed. The following is the design of the system to be developed.

- Dashboard Page

This page is designed to display news or information provided by Puskesman to website visitors without requiring them to log in to the system.

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Figure 3. Dashboard Page

- Login Page
  The login menu is the first menu you see when accessing the dashboard page.

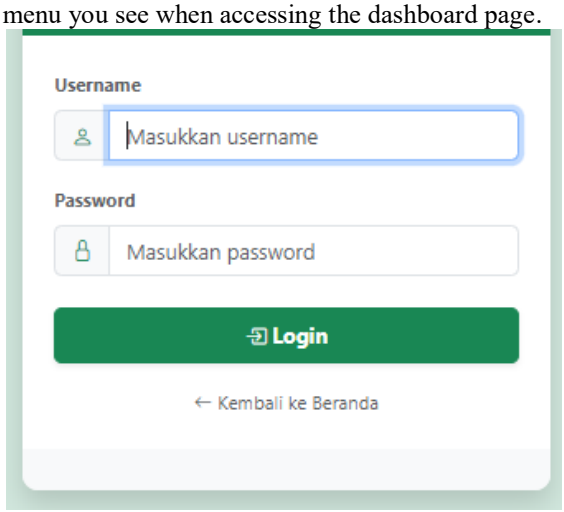


Figure 4. Login Page

- Dashboard Admin
  The admin dashboard menu is used to manage the prediction system. From this menu, the admin can enter the year of data collection, input data on pregnant women, and run the decision tree prediction process.

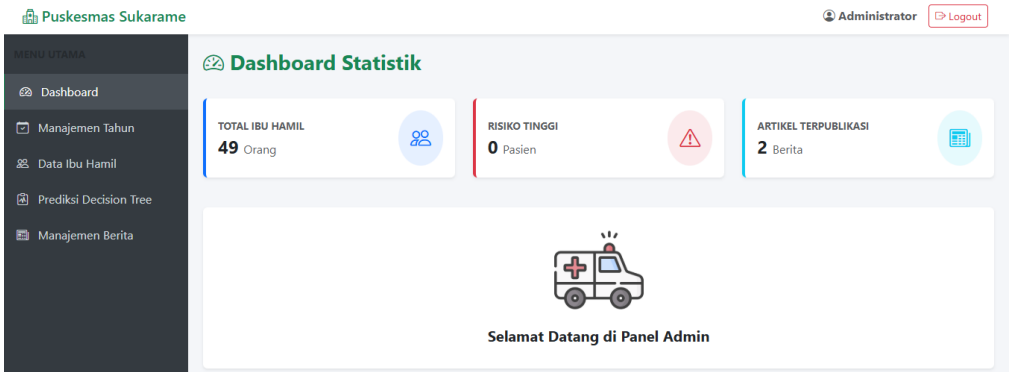


Figure 5. Dashboard Admin

- Year Management
  This menu is used by administrators to enter the year of registration for pregnant women.

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Figure 6. Year Management

- Data on Pregnant Woman

This menu is used by administrators to enter data on pregnant women into the system; the data entered consists of the patients' medical records.



Figure 7. Data On Pregnant Woman

- Decision Tree Prediction

This menu is used by administrators to run the Decision Tree algorithm for predicting the risk level of a pregnant woman's pregnancy based on the symptoms entered.

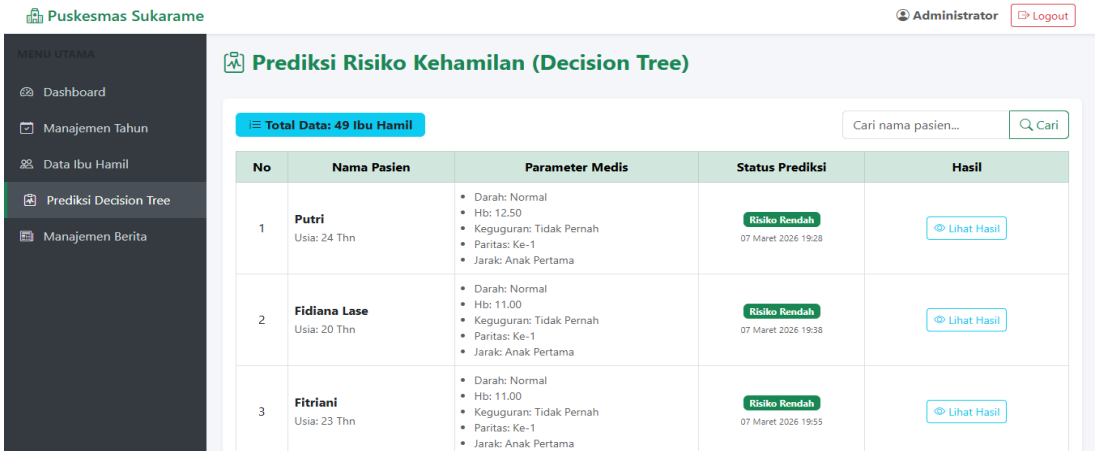


Figure 8. Decision Tree Prediction

- Management News

This menu is used by administrators to manage news posts or information provided by the Community Health Center to users.

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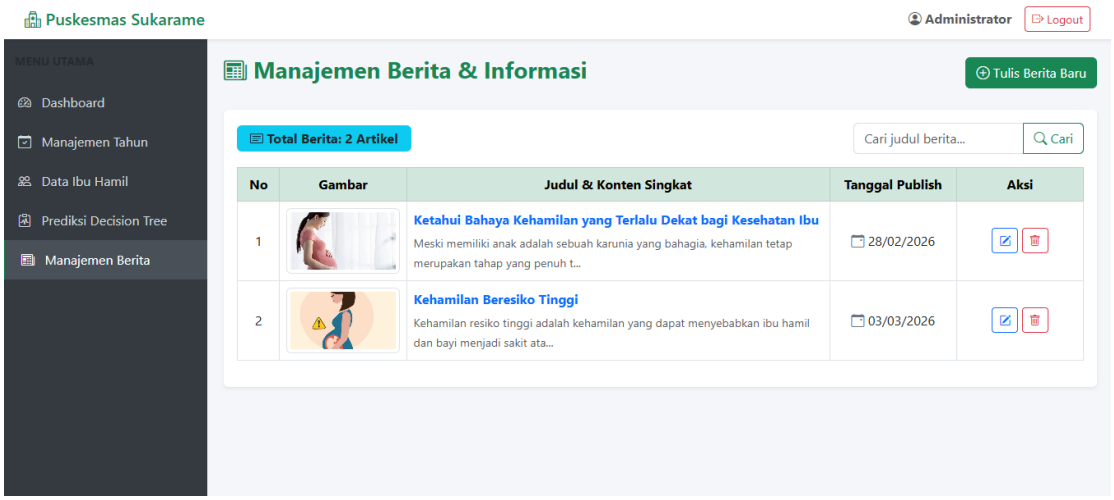


Figure 9. Management News

- Report Prediction

This menu allows the Head of the Community Health Center to view and print reports on patient predictions generated using a decision tree algorithm.

PUSKESMAS SUKARAME

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LAPORAN REKAPITULASI DATA IBU HAMIL TAHUN 2025

Total Pemeriksaan : **49 Pasien**
Tahun Periode : 2025
Tanggal Dicetak : 09 Maret 2026

Risiko Tinggi	Risiko Rendah	Belum Diproses
0	4	45

Rincian Data Pasien:

No	Nama Pasien	Usia	Tanggal Periksa	Tekanan Darah	Hb	Hasil Klasifikasi
1	Komalia	31 Thn	06 Januari 2025	Normal	12.00	Belum
2	Eli Suriani	35 Thn	07 Januari 2025	Normal	10.60	Belum
3	Susilawati	42 Thn	08 Januari 2025	Normal	11.00	Belum
4	Sri Ulfa	25 Thn	09 Januari 2025	Normal	10.50	Belum
5	Nur Syafitri Wijayanti	22 Thn	10 Januari 2025	Normal	11.50	Belum
6	Ramsia	36 Thn	11 Januari 2025	Normal	11.80	Belum
7	Sari	32 Thn	12 Januari 2025	Normal	13.10	Belum
8	Sikin	19 Thn	13 Januari 2025	Normal	9.00	Belum
9	Sumini	38 Thn	14 Januari 2025	Normal	10.00	Belum
10	Chintia Simanjuntak	25 Thn	15 Januari 2025	Normal	10.50	Belum
11	Irwana	36 Thn	16 Januari 2025	Normal	11.00	Belum

Figure 10. Report Prediction

DISCUSSION

Before the implementation of the Decision Tree algorithm, the process of identifying high-risk pregnancies at the Sukarame Community Health Center was conducted manually by healthcare workers based on direct observations and subjective assessments. Although medical records of pregnant women were available, the data was primarily used for administrative reporting rather than systematic risk prediction. This manual approach often resulted in inconsistencies in determining pregnancy risk levels and made the early detection process less effective, especially when handling large

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amounts of patient data. In addition, the absence of an automated classification system caused healthcare workers to require more time in analyzing patient conditions and determining appropriate interventions.

After the implementation of the Decision Tree algorithm, the pregnancy risk prediction process became more structured, objective, and systematic. The system is able to classify pregnant women into low, moderate, and high-risk categories based on medical attributes such as maternal age, blood pressure, hemoglobin levels, pregnancy history, and clinical symptoms. The Decision Tree model also generates clear decision rules that are easy for healthcare workers to understand and apply in practice.

Furthermore, the use of a web-based system accelerates the prediction process and minimizes the possibility of human error in risk classification. Healthcare workers can obtain prediction results more quickly and accurately, enabling earlier monitoring and intervention for high-risk pregnancies. Therefore, the implementation of the Decision Tree algorithm significantly improves the effectiveness and efficiency of pregnancy risk prediction at the primary healthcare level.

CONCLUSION

Based on the research conducted at the Sukarame Community Health Center, several conclusions can be drawn: medical records of pregnant women, which were previously used only for administrative reporting, can be processed using data mining techniques to generate more useful information. Through data processing steps such as data cleaning, transformation, and classification, the system can identify patterns of relationships between maternal health factors and pregnancy risk levels in a more systematic manner. The Decision Tree method used in this study constructs a decision tree based on maternal health attributes such as age, blood pressure, hemoglobin levels, medical history, and other medical factors. These decision trees generate classification rules that can assist healthcare providers in determining pregnancy risk levels more objectively and in a way that is easier to understand. The implementation of a web-based system enables the data processing and prediction of pregnancy risks to be performed automatically. With this system, healthcare providers can more quickly identify pregnant women at risk of complications, allowing for earlier monitoring and intervention to improve the quality of maternal healthcare services.

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