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ANDROID-BASED SMART SYSTEM FOR FRUIT SELECTION TO PREVENT TODDLER STUNTING

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Abstract: Preventing stunting in toddlers is crucial for improving children's health and growth. Stunting occurs due to chronic nutritional deficiencies during the first 1,000 days of a child's life, affecting their height, cognitive development, and immune system, which can reduce their future potential. Fruits play an important role in a toddler's diet because they are rich in vitamins, minerals, fiber, antioxidants, and other bioactive compounds that support physical growth and brain development. However, selecting the right fruits is vital because some fruits can cause digestive issues or allergies in toddlers. To assist parents in choosing the right fruits, a mobile-based expert system using the Certainty Factor method has been developed. This system provides recommendations based on the toddler's health condition and evaluates the nutritional content of fruits. With this system, parents can ensure that their toddlers receive optimal nutrition, contributing to stunting prevention and ensuring that the toddlers grow up healthy, intelligent, and with full potential in the future Choosing the right fruits and maintaining a balanced nutrition are crucial parts of supporting the sustainability of stunting prevention efforts.

Keywords: certainty factor method; expert system; fruit selection; stunting prevention; toddler nutrition

Abstrak: Pencegahan stunting pada batita sangat penting untuk meningkatkan kualitas kesehatan dan pertumbuhan anak. Stunting terjadi akibat kekurangan gizi kronis pada 1.000 hari pertama kehidupan batita, memengaruhi tinggi badan, perkembangan kognitif, dan sistem imun anak, yang berisiko mengurangi potensi masa depan mereka. Buah-buahan memiliki peran penting dalam pola makan batita, karena kaya akan vitamin, mineral, serat, antioksidan, dan senyawa bioaktif yang mendukung pertumbuhan fisik dan perkembangan otak. Namun, pemilihan buah yang tepat sangat penting karena beberapa buah dapat menyebabkan masalah pencernaan atau alergi pada batita. Untuk membantu orang tua dalam memilih buah yang sesuai, dikembangkan sistem pakar berbasis mobile dengan metode Certainty Factor. Sistem ini memberikan rekomendasi berdasarkan kondisi kesehatan batita, serta mengevaluasi kandungan nutrisinya. Dengan sistem ini, orang tua dapat memastikan bahwa batita mendapatkan nutrisi yang optimal dengan berkontribusi dalam pencegahan stunting dengan memastikan batita tumbuh sehat, cerdas, dan memiliki potensi penuh di masa depan. Pemilihan buah yang tepat dan nutrisi yang seimbang menjadi bagian penting dalam mendukung upaya keberlanjutan pencegahan stunting.

Kata kunci: batita; metode certainty factor; pemilihan buah; pencegahan stunting; sistem cerdas

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INTRODUCTION

Stunting in toddlers is a critical public health issue in Indonesia, with severe long-term consequences for children's physical growth and cognitive development[1]. One of the major determinants of stunting is inadequate nutritional intake, particularly insufficient consumption of nutrient-rich foods such as fruits. However, many parents or caregivers struggle to choose the right fruits and maintain a balanced diet for their toddlers due to a lack of knowledge or guidance [2].

Although the Ministry of Health reported a slight decrease in the stunting rate from 24.4% in 2021 to 21.6% in January 2022, stunting remains a pressing concern that demands continuous efforts in prevention and intervention[3] The Family Companion Team (TPK), established across various regions of Indonesia, plays a vital role in addressing stunting with a target to reduce the incidence to 14% by 2024 [4] Despite these initiatives, the issue of selecting nutritious fruits for toddlers remains a challenge for many families, requiring innovative solutions.

The advancement of computer technology presents an opportunity to develop intelligent systems that can assist parents and caregivers in selecting the best fruits for toddler nutrition, thereby contributing to stunting prevention efforts However, there has been limited progress in Indonesia towards creating such intelligent systems, despite the high need given the persistent stunting rates [5].

This research introduces an expert system that leverages the Certainty Factor (CF) method to help families determine the most appropriate fruits for their toddlers. The Certainty Factor method is widely used in expert systems to express the degree of confidence in decision-making, simulating expert knowledge by assigning certainty values based on data or expert opinion [6]. By incorporating the CF method, the proposed system provides tailored fruit recommendations that address the specific nutritional needs of toddlers, aiming to improve the quality of their diet and reduce the risk of stunting [8].

Moreover, the system is developed as a mobile application using Java, making it accessible and user-friendly for parents and caregivers. The novel application of the Certainty Factor method in this context represents a practical solution to an urgent public health issue[8]. Through this research, we aim to support the ongoing national efforts to prevent stunting and promote healthy growth in Indonesian toddlers.

METHOD

The Certainty Factor (CF) method is an effective approach in expert systems for selecting fruits to prevent stunting in toddlers. It begins with creating a comprehensive knowledge base of various fruits, detailing their nutritional values and associated risks. Rules are established to assess each fruit's suitability based on the toddler's age, health status, and allergies, each assigned a certainty factor to indicate confidence in the recommendation. The system collects input from parents regarding their child's health conditions and dietary restrictions, then evaluates fruits against these rules to calculate their suitability. It provides a ranked list of recommended fruits, along with explanations to aid informed decision-making. The system is

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regularly updated to incorporate new data and adapt to changes in the toddler's health, ultimately supporting better nutrition and stunting prevention[9].

One way to gauge the certainty of a diagnosis-related issue is to use the Certainty Factor (CF) technique. In this study, a series of stages are carried out, starting from problem analysis to implementation of solutions, to develop the Smart System for Choosing Good Fruit Consumption for Stunting Prevention in Toddlers using an Android-based platform[10], The methodology process includes several key phases[11], More details of the research step as illustrated in image (1).

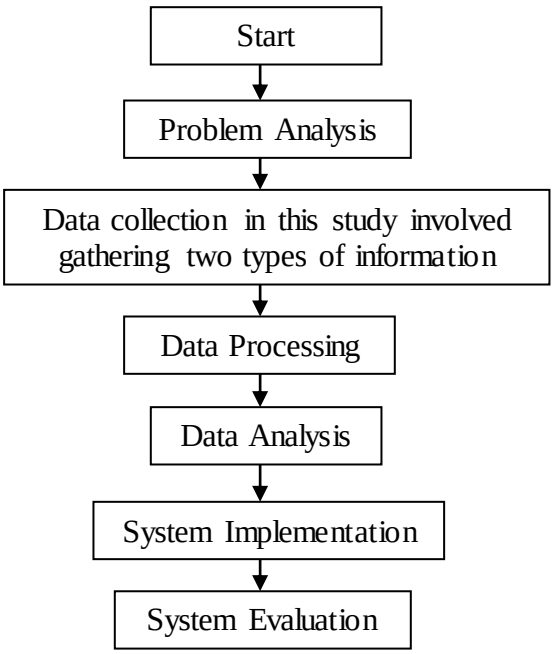

Image 1. Research Steps (1)

First is Start

This stage is the beginning of the research starting from designing and creating a research proposal and uploading it to the bima.kemdikbud.go.id website, to waiting for the announcement of the results and approval of the research.

Second is Problem Analysis

The initial stage involved identifying the key factors contributing to stunting in toddlers, specifically focusing on inadequate fruit consumption. This problem was analyzed through a combination of literature review and expert consultations with pediatric nutritionists and healthcare professionals. These experts identified fruits that provide essential nutrients for toddlers, as well as those that may cause digestive issues or allergies.

Third is Data collection in this study involved gathering two types of information: Information about the nutritional content of fruits commonly consumed in Indonesia is very important. For example, bananas and mangoes are fruits rich in vitamin A, vitamin C, and fiber, which can support the growth and development of toddlers and collecting data on the potential allergens of fruits and their digestibility is also very important. Some fruits can cause allergic reactions in children, such as strawberries and kiwi. Understanding the digestibility aspects also helps in choosing the right fruits for toddlers to prevent digestive issues.

Fourth is Data Processing

Once the data from experts and databases was collected, it was processed into a format that the system could use for Certainty Factor calculations. The following steps outline the data processing procedure:

First: Assigning CF Values: Each fruit was assigned a CF value, representing the level of certainty that a fruit is either beneficial or harmful for toddlers. These values ranged from 0 to 1, where a value closer to 1 indicated a higher level of confidence in the fruit’s benefits.

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Second: Rule Development: Based on expert consultations, a set of rules was developed to guide the system's decision-making process. For example, fruits rich in vitamin C and fiber were favored for toddlers, while those with high allergenic potential (e.g., strawberries or citrus fruits) received lower CF values.

Third: Certainty Factor Method: The CF method was implemented using the following formula [9]to combine multiple pieces of evidence about a fruit's suitability:

$$CF(H,E)=CF(H,E1)+CF(H,E2)\times(1-CF(H,E1))$$

This equation allows the system to combine both positive (e.g., nutritional value) and negative (e.g., allergenic potential) evidence to produce a final CF value for each fruit recommendation.

Fourth: Data Analysis

The system analyzes the data using the following steps: First, Input Processing: Users (parents or caregivers) input data about the toddler, including age, known allergies, and specific health conditions, into the mobile application. The system processes this input to determine which fruits are suitable based on the rules and CF values stored in the database. Second, Certainty Factor Calculation: For each fruit, the system evaluates how well it meets the toddler's nutritional needs and health conditions by calculating a CF value using the input data. The system dynamically adjusts the CF values for each fruit based on the combination of positive and negative factors (e.g., a fruit may be high in nutrients but have a moderate allergenic risk).

Fifth: Recommendation Output: After analyzing the input and calculating CF values, the system ranks the fruits based on their suitability for the toddler. The final output is a list of recommended fruits, ordered from most to least suitable, with CF values indicating the level of certainty for each recommendation.

Sixth: System Implementation. The system was developed for Android using Java in Android Studio. The collected data was stored in an SQLite database, which houses the fruit profiles and their respective CF values. The system's rule-based engine processes the input data in real-time, using the CF values to generate personalized fruit recommendations.

Seventh: System Evaluation. The smart system was tested in a real-world setting with parents and caregivers. Evaluation criteria included Accuracy: The system's fruit recommendations were compared against expert opinions to ensure that the CF-based recomme ndations aligned with professional guida nce and User Satisfaction: Feedback from parents and caregivers was gathered to assess the usability of the system and the clarity of the recommendations.

Certainty Factor

The implementation of the Certainty Factor (CF) technique, originally proposed by Shortliffe and Buchanan, has proven to be an effective method for addressing the uncertainty and imprecise reasoning often encountered by experts, such as doctors, in making recommendations [12]. In order to account for this, the expert's degree of confidence in the issue at hand is expressed using the Certainty Factor (CF). There are two methods to determine a rule's level of confidence

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(CF), which are as follows [13]:

Net Belief Method The Net Belief technique put out by E. H. Shortleffe and B. G. Buchanan [14] .

CF(Rule) = MB(H, E) – MD(H, E).....(4-10)

$$MB(H, E) = \begin{cases} 1 & P(H) = 1 \\ \frac{\max[P(H|E),P(H)] - P(H)}{\max[1,0] - P(H)} & \end{cases}$$

$$MD(H, E) = \begin{cases} 1 & P(H) = 0 \\ \frac{\max[P(H|E),P(H)] - P(H)}{\max[1,0] - P(H)} & \end{cases}$$

Description:
CF (Rule): Certainty factor, MB(H, E): Measure of Belief (measure of belief) towards hypothesis H, if given evidence E (between 0 and 1). MD(H, E) is Measure of Disbelief (measure of uncertainty) towards evidence H, if given evidence E (between 0 and 1). P(H) is Probability of truth of hypothesis H, and P(H|E) is Probability that H is true given fact E. The expert's elucidation of the "term" yields the CF (Rule) value, which is changed to a particular amount in accordance with the certainty table that follows:

Table 1. Certainty Values

Value	Uncertain Term	CF
1	Definitely not	-1.0
2	Almost certainly not	-0.8
3	Probably not	-0.6
4	Maybe not	-0.4
5	Unknown	-0.2 to 0.2
6	Maybe	0.4
7	Probably	0.6
8	Almost certainly	0.8
9	Definitely	1.0

In this input needs analysis to find out which fruits are good for toddlers to consume using the Certainty Factor method, namely through an indicator data along with certainty values (MB) and uncertainty values (MD) provided by an expert. The data will later be processed to produce conclusions about which fruits are good for toddlers[15].

The following is the fruit indicator data:

Table 2. Fruit Indicator

Indicator Code	Information
K1	Contains protein
K2	Contains fat
K3	Contains iron
K4	Contains minerals
K5	Contains fiber
K6	Contains Vitamin A

The Certainty Factor method's computation results are as follows:

A1. Avocado
The CF value is = 0.32658
A2. Apple
The CF value is = 0.729
A3. Starfruit
The CF value is = 0.23813999
A4. Orange
The CF value is = 0.29027992
A5. Mango
The CF value is = 0.14111996
A6. Papaya
The CF value is = 0.40319997
A7. Banana
The CF value is = 0.5832
A8. Soursop
The CF value is = 0.12672001

So fruit that is good for toddlers is A.2 apples with a CF value of 0.729

System Design

Use case diagrams show the

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interaction relationship between actors or main actors and use cases in a system which aims to determine how actors interact with a system. A use case diagram is shown below for an expert system for determining fruit that is good for toddlers to consume using the Certainty Factor method:

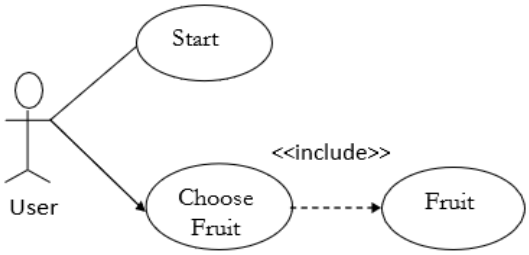

Image 2. Use Case Diagram

RESULT AND DISCUSSION

System Interface Display

This section provides a comprehensive overview of the system interface for the expert system, detailing each component's functionality and user interaction.

Main Page Display

The home screen that shows up when the user launches the application is seen below.

Image 3. Main Page Display

Display the Select Type of Fruit Form

The following is a display of the select type of fruit form which functions to select the fruit whose value you want to know.

Image 4. Display the Select Type of Fruit Form

Result Form Display

The following is a outcomes form display which functions to display the results of the selected fruits.

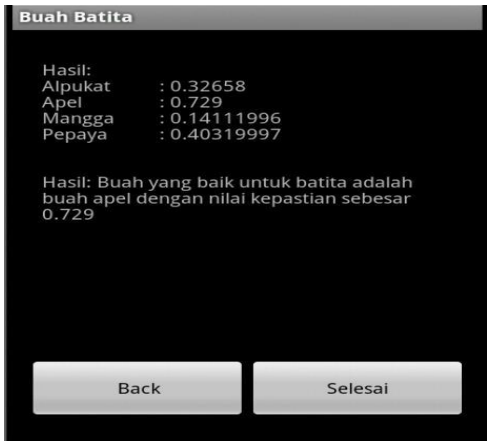

Image 5. Display of Design Results

So, an apple with a CF value of 0.729 is a good fruit for toddlers that was discovered through system testing and utilizing the confidence factor approach.

CONCLUSION

From the research process carried out, there are several things that can be concluded namely : The Certainty Factor method is a method in an intelligent system for carrying out fairly accurate calculations in the process of determining which fruit is good for toddlers. With an expert system application to determine which fruit is good for toddlers, it can make things easier for users, and the system built is not perfect in solving the problem of determining good fruit for toddlers.

The author suggests more study in the following ways to support it: initially, this research has to be developed further before it can be applied as a true expert system. It is best to develop this application so that the results are better. For further application development, other methods can be used as a comparison of the expected results.

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