Design and Construction of a Certainty Factor-Based Nutrition Consultation System with the Prototyping Method for Stunting Prevention in Coastal Areas

Fajar Ratnawati[1], Niky Hardinata[2], Supendi[3], Rindi Devi[4]
[1,2,3,4]*Department of Informatics Engineering, Politeknik Negeri Bengkalis, Indonesia*)
fajar@polbeng.ac.id[1], nikyhardinata@polbeng.ac.id[2], supendi02@polbeng.ac.id [3],
rindidevi689@gmail.com[4]

Abstract

Stunting remains a serious health problem in Indonesia, particularly in coastal areas where access to health services is limited and nutritional knowledge among communities is relatively low. This study aims to design and develop a nutrition consultation system based on the Certainty Factor (CF) method using the Prototyping approach as an effort to support stunting prevention. The research began with the identification of user requirements, followed by the design of a knowledge base and rule base using CF to process symptoms and nutritional indicators. The system was implemented into an application prototype and iteratively validated by nutrition experts and users. Black-box testing showed that all functional modules, including registration, login, nutritional diagnosis, and information management, worked properly. Furthermore, a usability test involving 25 respondents was conducted to measure user experience in terms of learnability, effectiveness, memorability, error, and satisfaction. The results indicated an overall average usability score of 4.08 (Good category), with learnability and satisfaction rated highest, while error handling and memorability still require improvements. These findings suggest that the developed CF-based consultation system can serve as an effective and accessible technological solution to provide nutritional recommendations for coastal communities, thus contributing to efforts in reducing stunting prevalence.

Keywords : Stunting prevention, Nutrition consultation system, Certainty Factor, Prototyping, Usability testing

1. INTRODUCTION

Stunting is a serious health problem that remains prevalent in Indonesia, particularly in coastal areas. This condition is characterized by stunted physical growth and cognitive development in children due to chronic malnutrition (WHO, 2021). Data from the Indonesian Ministry of Health shows that the prevalence of stunting in coastal areas is relatively higher than in other regions, influenced by limited access to health services, low levels of public nutrition knowledge, and consumption patterns that do not meet children's nutritional needs (Kemenkes RI, 2022; Bappenas, 2021).

To address this problem, a platform is needed that can provide nutritional information quickly, accurately, and easily accessed by coastal communities. Expert systems are one technological solution that can be implemented because they can mimic the decision-making process of an expert through a knowledge base (Turban & Aronson, 2018). The Certainty Factor (CF) method is widely used in expert systems to accommodate the expert's level of confidence in a symptom and generate probability values that can be used as a basis for providing nutrition consultations (Durkin, 1994; Kusumadewi, 2010). With this approach, the system can provide recommendations that more closely reflect real-world conditions.

To ensure the system is tailored to user needs, the Prototyping development method was chosen because it can generate application designs through the creation of initial models (prototypes) that can be iteratively evaluated (Pressman & Maxim, 2019). Prototyping allows for active engagement between developers, nutrition experts, and potential users, allowing the system to be gradually refined to meet both functional and non-functional needs.

Based on this background, this study aims to design and build a Certainty Factor-based nutrition consultation system using the Prototyping method to support stunting prevention in coastal areas. It is hoped that the results of this study can provide an alternative information technology-based solution that is effective, easy to use, and provides tangible benefits for increasing nutritional awareness in coastal communities..

2. REVIEW OF LITERATURE

Stunting is a condition of growth failure in children due to chronic, long-term malnutrition, characterized by a child's height being lower than the standard for their age. This condition impacts not only physical health but also cognitive development and long-term productivity. The WHO (2021) report and the Indonesian Nutritional Status Study (Kemenkes RI, 2022) indicate that the prevalence of stunting remains high, especially in coastal areas. This is due to limited access to health services, low nutrition education, and consumption patterns that do not meet nutritional needs. Therefore, technology-based media are needed that can provide nutrition information quickly, accurately, and easily accessed.

Expert systems are one artificial intelligence-based solution that can mimic the decision-making abilities of an expert by utilizing a knowledge base and inference engine (Turban & Aronson, 2018). In the context of nutrition, expert systems can help detect the risk of malnutrition or stunting and provide recommendations for appropriate food consumption. One method widely used in expert systems is the Certainty Factor (CF). This method was introduced by Shortliffe and Buchanan in the MYCIN medical system in 1975 to accommodate uncertainty in decision-making (Durkin, 1994). Using CF, expert systems can calculate the confidence level of a hypothesis based on user-provided symptoms, resulting in more realistic results.

In software development, the prototyping method is preferred because it allows developers to build an initial application model, then validate it with users and experts before the final system is finalized (Pressman & Maxim, 2019). This iterative approach is particularly relevant for nutrition consultation applications, as the needs of coastal communities can vary and require continuous improvement.

Several previous studies have demonstrated the application of Certainty Factor in the health and nutrition sector. Kusumadewi (2010) utilized CF for an expert system for diagnosing diseases with a reasonable level of accuracy. Sari et al. (2020) developed an expert system for early detection of malnutrition using CF, and the results showed that the system can assist healthcare professionals in making decisions more quickly. Wijaya and Handayani (2021) designed a mobile-based nutrition consultation application using the CF method, which makes it easy for users to obtain nutritional recommendations based on input data. Another study by Pratama et al. (2022) integrated CF into a web-based expert system for monitoring the nutritional status of toddlers, and trial results demonstrated good acceptance among healthcare professionals.

These studies demonstrate that the CF method is quite reliable in addressing uncertainty issues in health expert systems. However, most studies have focused solely on general malnutrition detection. Few studies have specifically combined Certainty Factor (CRF) with the Prototyping development method to build a nutrition consultation application aimed at preventing stunting in coastal areas. Therefore, this research makes an important contribution in providing a technology-based system that meets community needs and complements previous research.

3. METHOD

This research used the Prototyping software development method, as it is suitable for applications requiring rapid validation from users and nutrition experts. This method allows for

the creation of an initial system model that can be repeatedly evaluated to ensure the final result truly meets the needs of coastal communities. An illustration of the prototyping method can be seen in the following figure.

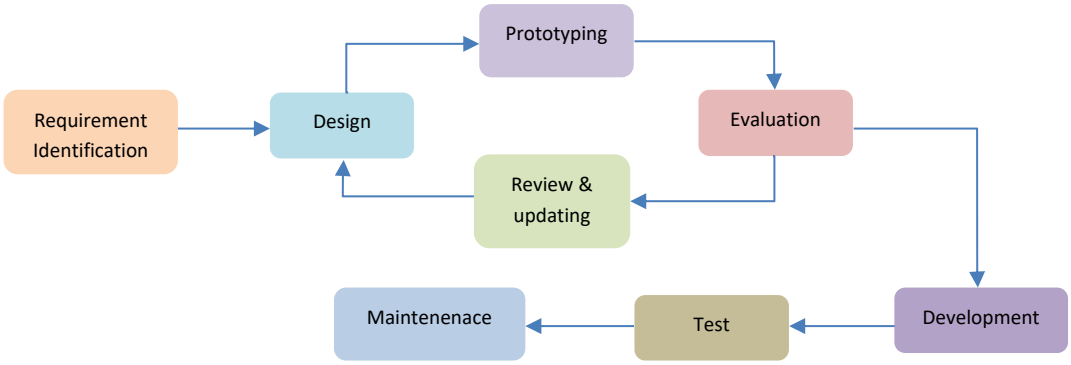


Fig. 1. Research Phase

The research phase begins with needs identification. At this stage, data related to stunting and child nutrition in coastal areas are collected through literature reviews and secondary data on stunting and nutritional needs, data from the Ministry of Health, and interviews with nutrition experts. The information collected includes symptoms, nutritional status indicators, and guidelines used in the consultation process..

Next, a system design was conducted, including the development of a knowledge base, rule base, and inference flow design using the Certainty Factor method. Each symptom and nutritional condition was assigned a measure of belief and a measure of disbelief, obtained from experts. The Certainty Factor calculation was carried out using the following formula:

$$CF[H,E] = CF[H] * CF[E] \quad (1)$$

Description:
a. H is the hypothesis or initial assumption regarding the symptom.
b. E is evidence or facts and events experienced by the user regarding the symptom.

The following is a picture of a system architecture based on certainty factor.

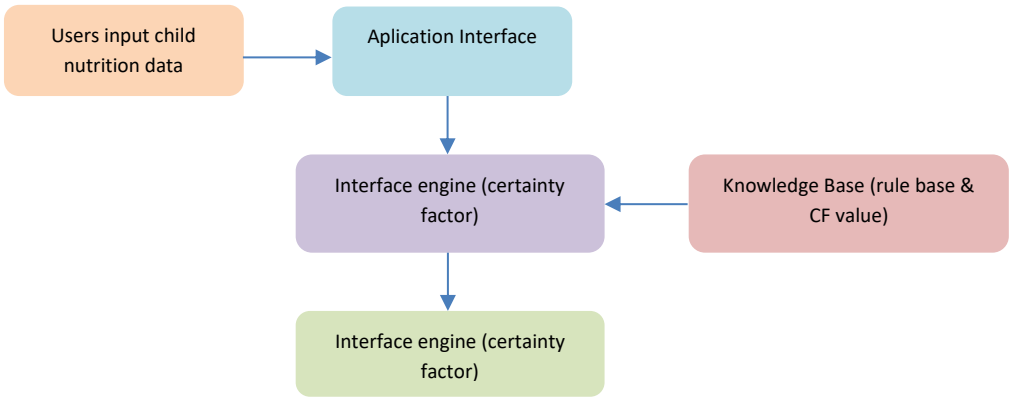


Fig. 2 Certainty factor-based system architecture.

This design was then implemented in the form of an initial application prototype, equipped with a user data input module (weight, height, age, diet), a CF rule base, and an output module containing nutritional consultation results and recommendations.

The prototype was then validated by involving nutrition experts and users from coastal communities. Validation was carried out by providing several real-life case scenarios, then

comparing the application results with the expert analysis. This stage provided input regarding the accuracy of the rules, the suitability of the recommendations, and the application interface.

The next stage was system refinement. The prototype was revised based on the feedback, including certainty factor calculations, the knowledge base, and the interface design. This process could last for several iterations until the system reached a stable and usable form. To measure the system's quality, black-box testing was conducted on functional aspects and the accuracy of the consultation results was evaluated by comparing the application's output with the nutrition experts' decisions. Furthermore, user testing was conducted to assess usability, particularly for coastal communities.

Through this research process, it is hoped that the resulting system will assist coastal communities in obtaining fast, easy, and sufficiently accurate nutritional consultations as part of stunting prevention efforts.

4. RESULT & DISCUSSION

The result of this research is a Certainty Factor-based nutrition consultation expert system application developed using the Prototyping method. The application is designed to assist coastal communities in obtaining information on child nutrition and providing recommendations for stunting prevention.

The next stage is the design of a Certainty Factor-based nutrition consultation expert system. This system design includes use case diagrams and activity diagrams to explain the activities occurring within the system. As seen in Figure 3, a use case diagram is a diagram that aims to illustrate all activities performed by the system from the user's perspective.

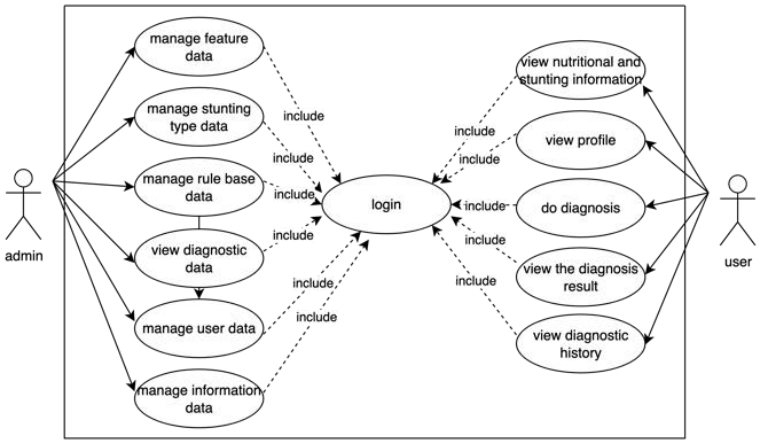


Fig.3. Usecase Diagram

Meanwhile, Figure 4 explains the activity diagram which shows the flow from one activity to another in the system.

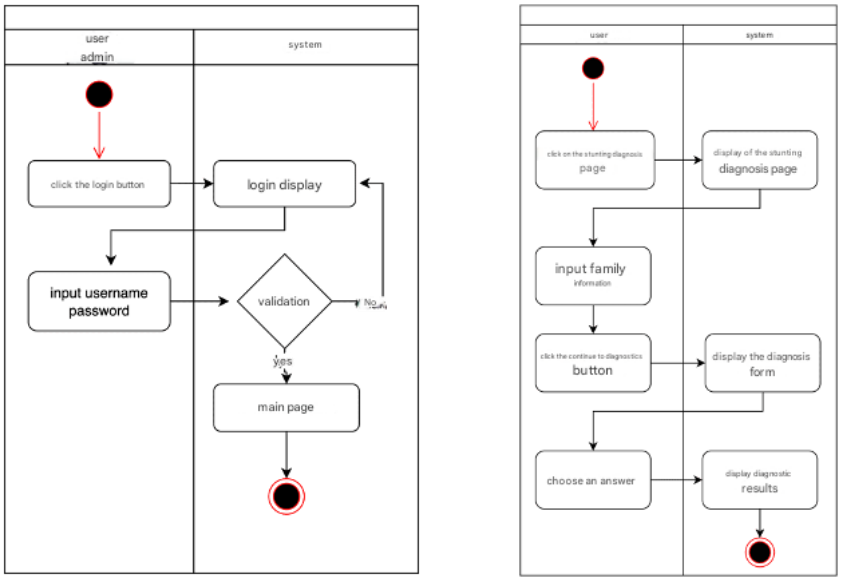


Fig. 4. Activity Diagram

The next stage is to create a system design which can be seen in Figure 5, Figure 6 and Figure 7.



Fig. 5. Admin login page

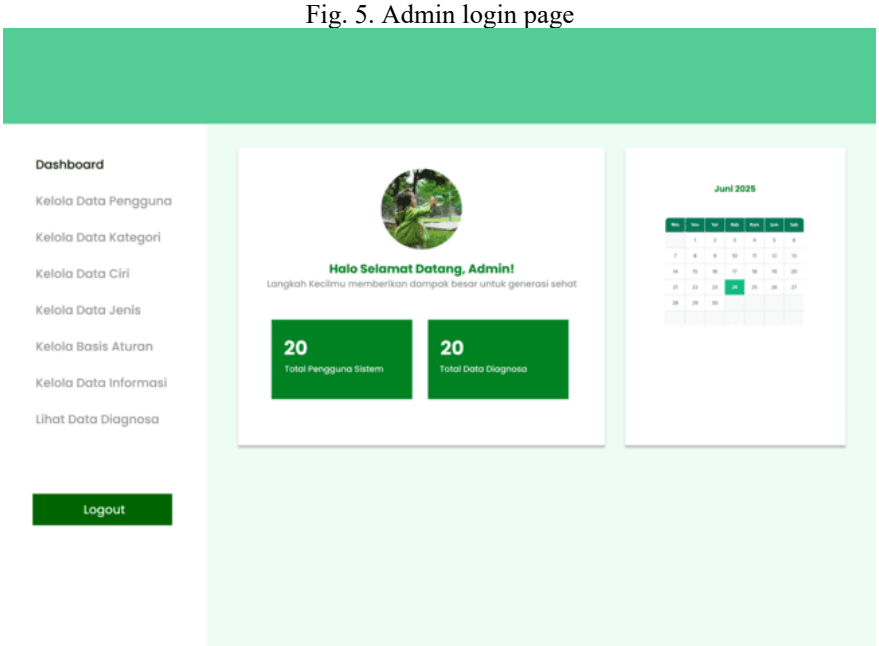


Fig. 6. Admin dashboard page

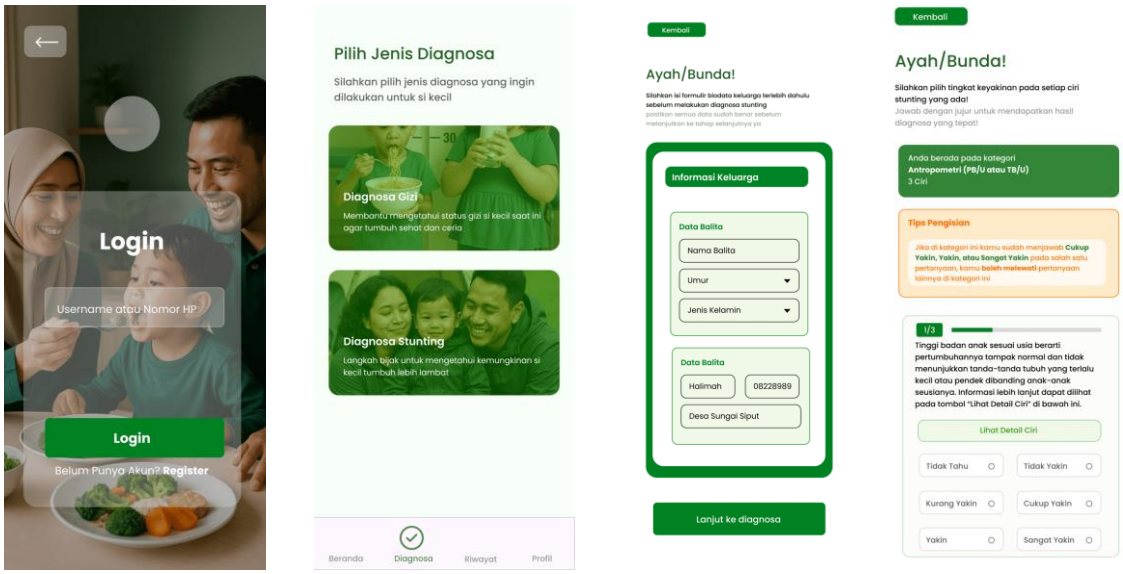


Fig. 7. User page view

The next stage is the system evaluation stage. The author conducted testing using blackbox testing and usability testing. Blackbox testing is a software testing method that analyzes software functionality by comparing input values with output values. The results of the blackbox testing aim to determine whether the information system design is acceptable, as described in Table 1.

Table 1. Table Functionality Testing

User Level	Key Features	Short Description	Status
Admin	Login & Account Management	Login, add admin, add parent, manage account	Succeed
	Stunting & Nutrition Characteristics Data Management	Add, edit, delete stunting characteristics & nutritional status	Succeed
	Category & Type Management	Add, edit, delete categories & types of stunting/nutrition	Succeed
	Rule Base Management	Add, edit, delete stunting & nutrition rule base	Succeed
	Information Management	Add, edit, delete information for users	Succeed
	View Diagnostic Results	Access the list & details of user diagnostic results	Succeed
Parents of Toddlers	Registration & Login	Account registration, login, logout	Succeed
	Access to Information	View list & detailed information	Succeed
	Stunting & Nutrition Diagnosis	Fill out the diagnostic questionnaire → see results	Succeed
	Diagnostic History	View list & details of diagnosis history (stunting & nutrition)	Succeed
	Profile	View account profile data	Succeed

A usability test was conducted to assess the opinions of respondents acting as users regarding the nutrition consultation system. This test used 25 respondents, assessing their opinions based on questions provided based on the dimensions of learnability, effectiveness, memorability, error, and satisfaction. Users rated their experience using a Likert scale of 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). The results of the questionnaire can be seen in Table 2.

Table 2. Table usability testing questionnaire results

Dimensions	Question	1	2	3	4	5	Average	Category
Learnability	The application is easy to understand when first used.	0	1	2	12	10	4.4	Good
	I was able to quickly learn how to use the app's main features.	0	2	3	14	6	4.2	Good
	The interface guide/view helps me understand the usage flow.	0	1	4	13	7	4.3	Good
Effectiveness	The application supports me to complete the task properly.	0	1	5	13	6	4.1	Good
	The information I need is easy to find in the app.	0	2	3	12	8	4.2	Good
	The available features work according to my needs.	1	1	6	11	6	4.0	Good
Memorability	After not using the app for a while, I can still remember how to use it.	0	3	6	11	5	3.8	Very good
	The app menu and navigation are consistent so it's easy to remember.	1	2	5	12	5	3.9	Very good
	The icons and labels on the app help me remember its function.	0	2	4	13	6	4.0	Good
Error	I rarely experience errors when using the app.	2	3	7	9	4	3.6	Very good
	If an error occurs, the system provides a clear and helpful message.	1	2	6	12	4	3.8	Very good
	The mistakes I made can be easily corrected	1	3	5	11	5	3.7	Very good
Satisfaction	I feel satisfied using this application	0	0	3	10	12	4.5	Good
	The application display is attractive and comfortable to use	0	1	2	11	11	4.3	Good
	I am willing to use this application again in the future	0	0	4	10	11	4.4	Good

Based on the results of a usability questionnaire completed by 25 respondents using a Likert scale of 1–5, the overall average score was 4.08, which falls into the Good category. This indicates that the nutrition consultation app is generally easy to use, effective, and satisfactory to users.

5. CONCLUSION

Based on the research and testing results, it can be concluded that:

1. The study successfully designed and built a Certainty Factor (CF)-based nutrition consultation system using the Prototyping method to support stunting prevention in coastal areas.
2. This system is equipped with a toddler nutrition data input module, a knowledge base of CF rules, and an output module consisting of consultation results and nutritional recommendations.
3. Black-box testing results showed that all main system functions (registration, login, data management, nutrition and stunting diagnosis, and information management) functioned well and met expectations.
4. Usability testing involving 25 respondents, with the dimensions of learnability, effectiveness, memorability, error, and satisfaction, yielded an average score of 4.08 (category: Good). This indicates that the application is easy to use, effective, and provides a high level of user satisfaction.
5. However, the Error (3.7 – Fair) and Memorability (3.9 – Fair) aspects still need improvement to make the application more consistent, memorable, and able to provide clearer and more solution-oriented error messages.

6. Thus, this CF-based nutrition consultation system can be used as an effective and easily accessible information technology solution to help coastal communities increase nutritional awareness and prevent stunting in toddlers.

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