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ROEL PILLAS MALUBAY

COMMUNITY NUTRITION INFORMATION SYSTEM OF BARANGAY SAN ANDRES, CAINTA, RIZAL

Adviser:

KATRINA JOY M. ABRIOL-SANTOS
Faculty of Information and Communication Studies

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This paper prepared by ROEL PILLAS MALUBAY with the title: "COMMUNITY NUTRITION INFORMATION SYSTEM OF BARANGAY SAN ANDRES, CAINTA, RIZAL" is hereby accepted by the Faculty of Information and Communication Studies, U.P. Open University, in partial fulfillment of the requirements for the degree MASTER OF INFORMATION SYSTEMS.

KATRINA JOY M. ABRIOL-SANTOS
Adviser — Date Signed

DR. RIA MAE H. BORROMEO
MIS Program Chair — Date Signed

DR. ROBERTO B. FIGUEROA JR.
Dean
Faculty of Information and Communication Studies

Date Signed

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ABSTRACT

Barangay San Andres operates various health center satellites in Cainta, Rizal, which use a manual system for child nutrition record management across the satellite centers. The manual process causes data inconsistencies, leading to redundant record encoding and other errors, such as duplicate, incomplete, and outdated entries. The manual approach is also inefficient for searching and retrieving information, especially when individuals move between satellite centers or when records are lost due to damage or destruction of physical documentation.

From this analysis of existing issues, a Community Nutrition Information System (CNIS), a progress web application, was created to aid in the efficient management of nutritional status monitoring. The CNIS was developed using PHP and a MySQL database and included functions such as nutritional profiling, record management, and food and supplement recommendations.

Evaluations were carried out using the ISO/IEC 25010 software quality model, in which participants, including barangay health workers, parents, and IT/IS professionals, completed Likert-scale questionnaires to evaluate the software. Results indicated that the indicators considered “strongly agree” were followed by general favorable ratings of “agree.” Performance, load, and security testing further demonstrated efficient resource utilization, stable operation with up to 50 concurrent users, and protection against common web vulnerabilities.

Overall, the CNIS is efficient, reliable, and suitable for deployment to enhance the accuracy, efficiency, and security of community nutrition records in the said barangay.

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INTRODUCTION

Background of the Project

Community nutrition monitoring remained an important part of public healthcare because accurate records and continuous assessment were needed to identify children experiencing nutritional problems. In the Philippines, malnutrition continued to affect many children through conditions such as stunted growth, undernourishment, unhealthy dietary practices, and obesity. According to UNICEF Philippines (2021), nearly one-third of Filipino children experienced different forms of malnutrition (UNICEF Philippines, 2021). These nutritional concerns were often associated with socioeconomic conditions, food accessibility, and daily dietary habits.

Despite the undeniable importance of adequate nutrition for promoting health and development, preventive care—especially nutrition—seemingly was not prioritized. This problem remained prevalent nationwide, which several factors attributed to it, such as: (1) the continuing struggle of Filipinos with hunger and food insecurity, especially in rural communities (Inquirer.Net, 2024), (2) constant change of government leaders and their priority programs where fund allocation for nutrition initiatives were low (Inquirer.Net, 2024; Silvestre, Nuevo, Ballesteros, Bagas, & Ulep, 2023), and (3) the low turnout of medical check-ups in the Philippines as less than half of the Filipino population get to have annual medical check-ups and only a third of them go to check-ups when they do not feel well Conti (2023).

Barangay San Andres, the largest among the seven (7) barangays in Cainta, Rizal, has over 120,000 residents (Philippine Statistics Authority, 2024), with nearly twenty-eight percent (28%) of them under 15 years old (as of the 2020 census). It has six (6) health center satellites: (1) PFCI as the main one, (2) KABISIG, (3) Liwasang Bayan, (4) Felix, (5) Planters, and (6) Lakas-Bisig. While its local healthcare includes essential services like medical check-ups and vaccinations, these efforts are primarily curative rather than preventive (e.g., nutrition monitoring).

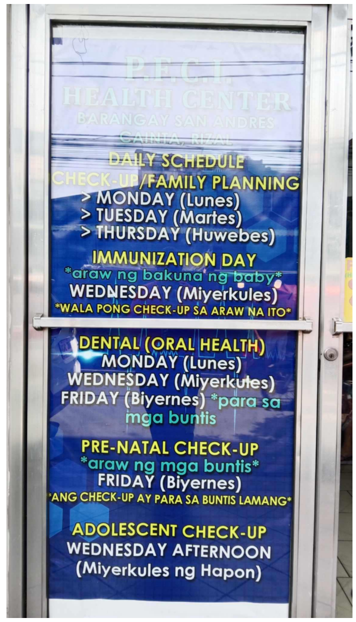
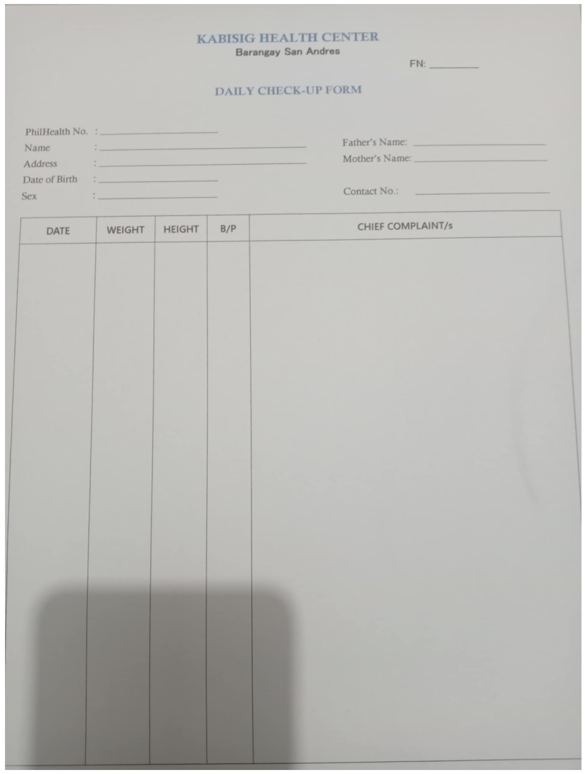


Figure 1. Barangay San Andres Health Center Services

Figure 1 displays the tarpaulin poster listing the services offered in Barangay San Andres' health center. All six (6) health center satellites offered general check-ups, family planning consultations, child immunizations, and prenatal check-ups. Meanwhile, only the PFCI main health center conducted dental check-ups, while the Lakas-Bisig satellite conducted adolescent check-ups.

The researcher conducted an initial inquiry and data gathering in Kabisig, one of the Barangay San Andres health center satellites. The informants were two (2) barangay health workers - a midwife and a Department of Health nurse deployed to the barangay. Their data collection method in their health centers used a manual, pen-and-paper approach, which was time-consuming, error-prone, and lacked adequate data security. The figure below shows a check-up form from Barangay San Andres Health Center.



KABISIG HEALTH CENTER
Barangay San Andres

FN: ________

DAILY CHECK-UP FORM

PhilHealth No. : ________
Name : ________
Address : ________
Date of Birth : ________
Sex : ________

Father's Name: ________
Mother's Name: ________
Contact No.: ________

DATE	WEIGHT	HEIGHT	B/P	CHIEF COMPLAINT/s

Figure 2. Barangay San Andres Health Center Checkup Form

The informants noted that all six health center satellites in Barangay San Andres collect identical data using the same forms. The primary health center (PFCI) was responsible for producing and distributing these check-up forms to the satellites. Each satellite modifies the heading on the forms to indicate its specific health center, as illustrated in the figure, where the check-up form is designated for the KABISIG health center.

(a) PFCI Main Health Center (b) Liwasang Bayan Satellite (c) KABISIG Health Center

Figure 3. Barangay Health Center Satellites

In addition, having multiple health center satellites (shown above are the images of three (3) of the six (6) Barangay San Andres health center satellites) led to unsynchronized and inconsistent data, resulting in redundant activities such as filling out the same form if a check-up is conducted at another satellite or if the original form is lost or damaged.

In effect, beneficiaries were selected randomly when nutrition initiatives like feeding programs and vitamin supplement distributions happened - hence, some children who actually needed these interventions were not included.

The operational bottlenecks of managing Barangay San Andres' health records inspired the idea of conceptualizing a Community Nutrition Information System (CNIS) as a progressive web application (PWA). Its goal was to track the children's nutrition records using digitally encoded and stored data and to ensure that the six (6) health centers were in sync with all records. The study sought to answer the following research questions:

1. How did the system provide an efficient, user-friendly way for data collection and processing?

2. What features and data were necessary to ensure accurate and up-to-date nutrition records to support targeted interventions?

3. How did the system guarantee security and data integrity?

4. What was the assessment of the target users and IT/IS professionals regarding the system based on the ISO 25010 Software Criteria?

With a shift toward preventive care, the CNIS could improve tracking and processing of nutritional data, promoting better health outcomes among the community's children.

Objectives

This study generally aimed to design, develop, and implement a web-based Community Nutrition Information System (CNIS) for Barangay San Andres, Cainta, Rizal. Specifically, the project objectives were to:

1. Build a streamlined, user-friendly platform for efficient health data collection
2. Identify and implement necessary features and data to deliver real-time, tailored dietary recommendations
3. Ensure data security and integrity within the system
4. Assess the proposed system by the target users and the IT/IS professionals using the ISO 25010 software criteria

Scope and Limitations

This study focused on the design, development, and implementation of a Community Nutrition Information System for Barangay San Andres, Cainta, Rizal.

Scope

The proposed Community Nutrition Information System of Barangay San Andres, Cainta, Rizal covered the following:

- The proposed system monitored the nutritional health status of children below 15 years old through the healthcare workers and the parents, who were the system's direct users.

- The project was developed as a progressive web-based application, making it accessible on multiple computer-based devices, such as desktops, laptops, tablets, and smartphones, without the need for installation and providing full offline tasks and data caching.
- The project was evaluated based on nutritional health status based on body mass index (BMI), arm circumference, medical history, food allergies, and restrictions.
- The proposed system also employed rule-based and knowledge-based system algorithms for nutritional assessment and dietary recommendations.
- The system was tested by several healthcare workers, ensuring representation from all six (6) health center satellites since they collect the same data using the check-up form.

Limitations

Due to certain constraints, this study had the following limitations:

- Target Demographics: The system did not include unborn babies, people aged 15 years old and above, and non-residents of Barangay San Andres.
- Data Quality and Availability: The system was intended to develop more accurate reports and recommendations. However, human errors during inputs can compromise the system's effectiveness and reliability.
- Data Synchronization: Progressive web applications could function fully and save data while offline, but a stable internet connection was still a must for timely synchronization and updates.
- Medical Diagnostics: The system did not include medical diagnosis of other illnesses.
- Dietary and Nutrition Assessment: The system provided dietary recommendations based on nutritional data, but it could never replace advice from medical professionals.

- Security and Privacy: The proposed system was dependent on available security measures, but may be limited in addressing advanced cybersecurity issues and the user's non-compliance with privacy protection protocols.
- Advanced Functionalities: Machine-learning-based predictive analytics was beyond the scope of this study.

Significance of the Project

The web-based CNIS provided a timely, accurate platform for tracking children's nutritional status in Barangay San Andres, benefiting multiple stakeholders, supporting the United Nations' Sustainable Development Goals (UNSDG) (United Nations, n.d.):

- Children: The system supported their growth and development by helping prevent nutrient deficiencies through tailored recommendations, addressing the UNSDGs Zero Hunger (2) and Good Health and Well-Being (3).
- Healthcare Workers and Parents: Real-time data and dietary recommendations empowered healthcare workers and parents to implement prompt, targeted interventions for children's nutrition, supporting Good Health and Well-Being (3) and Partnership for Goals (17) - cooperation among parents, health workers, and the healthcare system.
- Barangay Officials: Insights generated from the system's data analytics could guide them in health-related policies and decisions, contributing to community-level nutrition-related programs addressing Good Health and Well-Being (3) and Sustainable Cities and Communities (11).
- Community Residents: The improved tracking and evaluation of nutritional health was beneficial to Barangay San Andres constituents because of a more proactive approach to health management, based on the UNSDGs Zero Hunger (2) and Good Health and Well-Being (3).

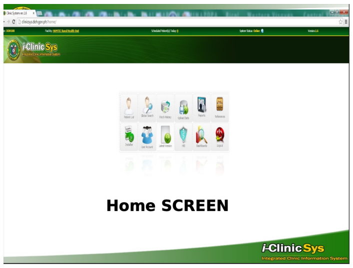
- Future Researchers: This study could be a reference for future projects of information systems and technology students and educators, contributing to academic research about health-related information systems, and offering a model system for other communities, promoting Quality Education (4) and Industry, Innovation, and Infrastructure (9).

REVIEW OF EXISTING ALTERNATIVES

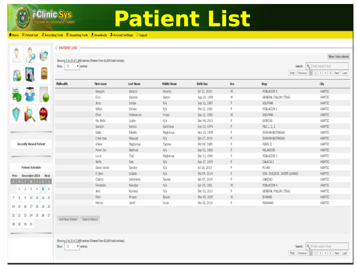
Due to its large land area and population, Barangay San Andres operated six (6) health centers, namely: PFCI, Kabisig, Laka-Bisig, Felix Subdivision, Liwasang-Bayan, and Planters. They heavily relied on pen-and-paper data collection. Every time a child went for a check-up, the parent repeatedly filled out the personal information section of the Patient Records form. At the same time, Barangay Health Workers (BHWs) recorded additional data, including height, weight, and vital signs. From the Patient Records forms, these children's data were copied into logbooks by hand, then encoded into a spreadsheet - the only computerized part of the process. When these kids returned for their follow-up check-ups, the BHWs still had to find their records in the forms, logbooks, or spreadsheets, which was inconvenient and time-consuming. Despite the Department of Health (DOH) providing iClinicSys (a centralized health information system), users struggled to use it consistently, often reverting to pen-and-paper methods.

Department of Health's iClinicSys

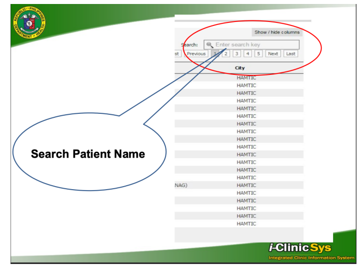
DOH's IClinicSys was designed to help manage and centralize health data across the Philippines. Its features included comprehensive patient data entry, review of patients' medical histories and treatment plans, and report generation. It also had a telemedicine function, allowing doctors to schedule consultation appointments with patients remotely (Department of Health, 2024; Municipal Health Office of Hamtique, Antique, 2016).



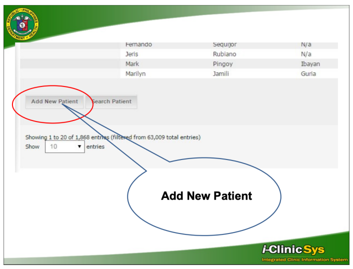
(a) iClinicSys Home Screen



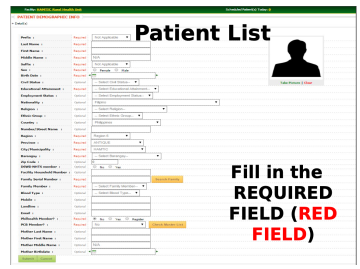
(b) iClinicSys Patient List



(c) iClinicSys Search Patient Feature



(d) iClinicSys Add New Patient Feature



(e) iClinicSys New Patient Information Form

Figure 4. Screenshots of the DOH's iClinicSys (Municipal Health Office of Hamtique, Antique, 2016)

iClinicSys was primarily an online system (with some offline features) accessible only on desktop or laptop computers, and did not work well on mobile phones. This limitation was a problem for health workers who only have phones (Department of Health, 2024; Rocha, 2024). Some iClinicSys users gave negative feedback, such as: (1) delayed responses to system inquiries and maintenance support, (2) unstable connectivity, (3) limited data sharing, and (4) difficult-to-navigate user interfaces (Evio & Bonito, 2024; Rocha, 2024).

The Community Nutrition Information System (CNIS) and iClinicSys were both health information systems, but the former was intended specifically for nutrition-related information and activities. The CNIS concept was similar to iClinicSys in its approach to collecting and managing health data. However, the proposed CNIS was specific to community nutrition, such as assessing kids' nutritional health status and recommending foods and supplements. And since the CNIS was a PWA: (1) it could work on mobile phones and tablets, (2) it did not need to be downloaded from the App Store or Google

Play Store, and (3) it could also work offline, which is helpful (Lingolu & Dobbala, 2022).

Desktop-Based Applications on Diet Recommendation Systems

To obtain more ideas for developing this study, several studies were reviewed to identify features that could improve the system. For instance, there was a project titled ”Aware Food Analysis System”. The system was developed to analyze food using artificial intelligence, using food photos without descriptions (Wu et al., 2022).

Figure 5. A Visually-Aware Food Analysis (VAFA) System for Diet Management Screenshots (Wu et al., 2022)

This desktop application provided users with information on the type of food, ingredients, and nutrients. It helped users better understand their diet. The system used multimedia inputs, such as food photos, to analyze them with AI algorithms. It provided food classification, ingredient identification, and nutrient analysis.

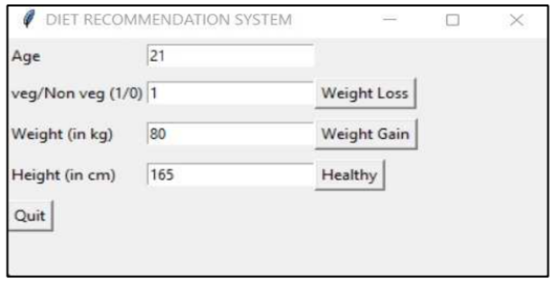


Fig 2. Diet Recommendation (Input)

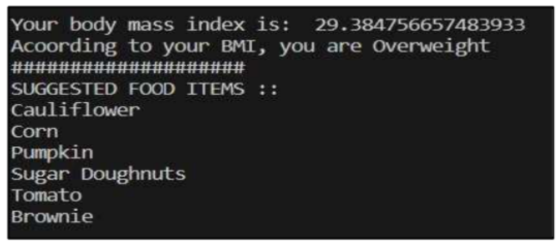


Fig 3. Diet Recommendation (Output)

Figure 6. AI Based Gym Trainer and Diet Recommendation System Screenshots (Balpande et al., 2023)

Another study developed an ”AI-powered gym-trainer and diet-recommendation system”. This system provided personalized health advice based on what people eat and how they exercise. One of its main modules provided a tailored list of food suggestions to help achieve one’s fitness goals (Balpande et al., 2023).

Mobile Health and Nutrition Applications

Mobile health apps helped bring healthcare to people who did not have access to it. For example, a 2020 study found that an Android app helped identify soon-to-be mothers whose babies might not be growing well in their wombs. This app used predictive modeling to figure out which women were at risk and then gave them personalized advice on what to eat (Oktaviana et al., 2020).

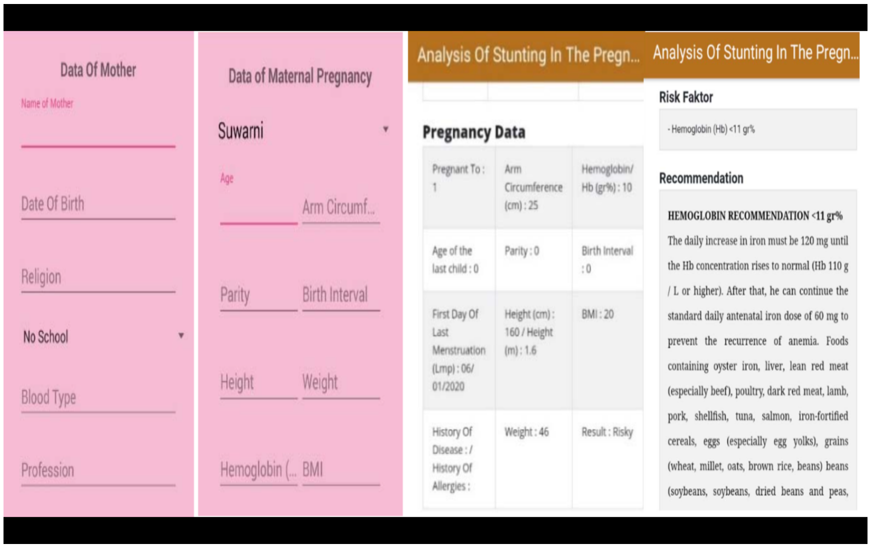


Figure 7. Early Detection of Stunted Growth App Screenshot (Oktaviana et al., 2020)

This mobile health app used a rule-based approach grounded in dietetic principles to customize meal plans for each woman. It looked at the individuals' health information to come up with a suitable meal plan for healthier pregnant women and their unborn babies.

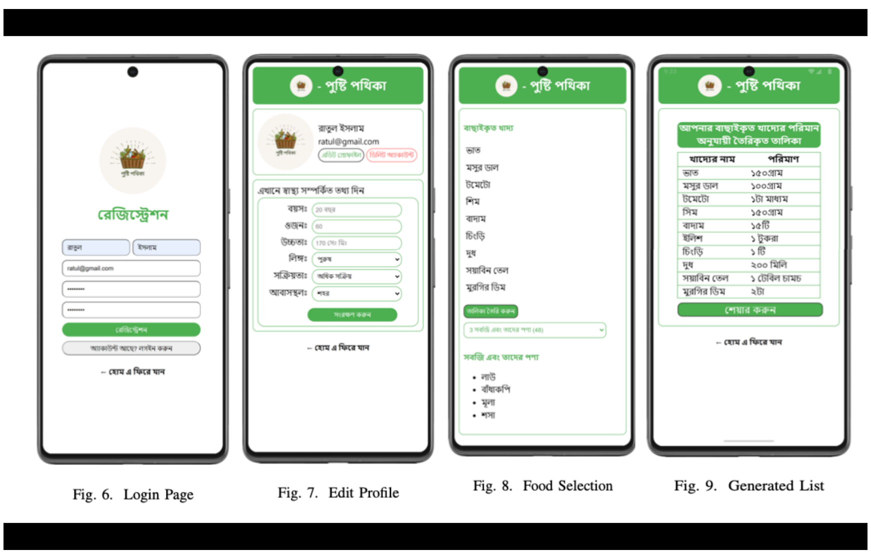


Figure 8. PushPotika App Screenshots (Halder et al., 2024)

Similarly, the PustiPothika application utilized a k-nearest neighbors (k-NN) machine learning algorithm to construct optimized meal schedules based on biometric factors such as age, sex, height, and weight (Halder et al., 2024). These mobile platforms maximize the said algorithm in automating the processes to obtain precise health data and status so as to generate the right meal plan for every person.

Drawing inspiration from these reviewed studies, the proposed CNIS was confirmed to be feasible as a mobile-ready progressive web application (PWA) that addressed the limitations of desktop-only systems. Furthermore, the system collected health metrics to provide reliable results and interpretations of one's health status. With the right findings, it could enable providing diet recommendations - a perfect fit for their specific needs.

Algorithm Approaches on Nutrition Assessment

Various computer algorithms were utilized to build accessible systems for customizing meal plans and food suggestions, such as the study that implemented K-means clustering and random forest algorithms to recommend appropriate foods based on participants' body mass index and health goals (Rout, Sethy, & Mouli, 2023).

Meanwhile, the "The El Combo" system used a rule-based and knowledge-based approach by considering meals they are allowed to eat due to their specific illness or condition while respecting their favorite foods. This system focused on the older people in a Chinese community as the target demographics (Xu, Li, & Topaz, 2023).

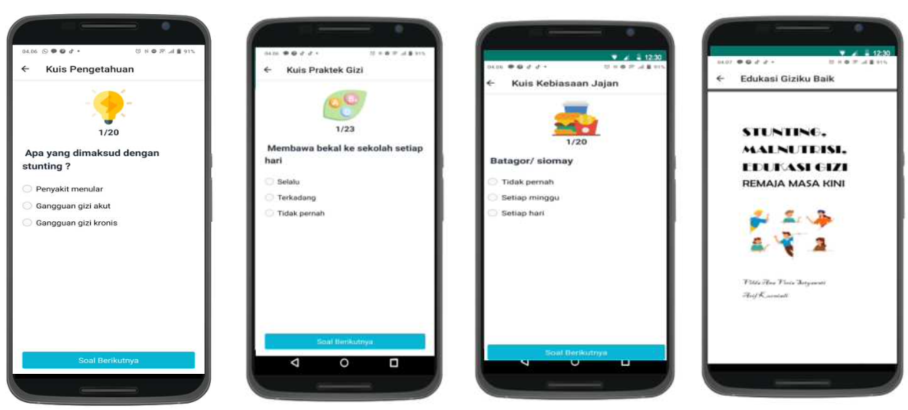


Figure 9. Gaiziku App Screenshots (Setyawati & Kurniadi, 2022)

The Gaiziku Baik application was another example of an application system that used a specific algorithm and focused on a particular demographic. It catered to teenagers and employed a knowledge-based approach, using their food preferences and eating habits to suggest diet plans for them (Setyawati & Kurniadi, 2022). There was also an available diet plan application for toddlers. It used the C5.0 Decision Tree Method to figure out whether these younger kids are getting the nutrients they need to be healthy. It also used height, weight, and arm circumference as base inputs. And in turn, the application would base the meal plans it provided on these details (Styawati, Nurkholis, Alim, Samsugi, & Asyad, 2024).

Reviewing the systems in this section revealed common ingredients for a successful implementation: (1) algorithms, (2) specific user profiles (age in these cases), (3) identified inputs, and (4) expected outputs. So to adapt, these elements would also be reflected in the CNIS project.

Food Recommender Systems

A 2024 paper reviewed different methods in creating food recommender systems. It identified and reviewed four (4) different approaches: (1) Content-based Filtering depends on the user's preferences and the characteristics of the food ingredients or nutritive value; (2) Collaborative Filtering relies on the recommendations shared among similar users, highly effective for popular food items but may be disadvantageous to new and unique ones; (3) Graph-based Method present food items and users as nodes and connected by lines to visualize the complex relationship of how ingredients work together to food recommendations much easier; and (4) Hybrid Methods are any combination of the first three (3) techniques mentioned (Bondevik, Bennin, Babur, & Ersch, 2024).

Another study published in 2024 used the Context-Aware Knowledge-Based System algorithm to generate personalized food recommendations based on user-specific information, such as age, health data, environmental factors, and food allergens (Matulessy & Baizal, 2024).

Figure 10. Food Recommendation with Balanced Nutrition App App User Interaction Chatbot Screenshots (Matulessy & Baizal, 2024)

It adapted the ontology design to categorize food items by nutritive content, a chatbot for user interaction, contextual awareness, wherein food recommendations are based on internal and external conditions like food allergies or weather, and food recommendation rules using the Semantic Web Rule Language to identify suitable food items for every user profile.

Synthesis

The Community Nutrition Information System (CNIS) project was a product of various ideas from a collection of published research. The main idea was not to make the processes computerized just for the sake of modernization, but instead, to centralize the health center records into a single database that would be a strong support for BHWs so they can offer faster and better nutrition-related services to families in the barangay.

The CNIS wanted to fix the problems the BHWs and patients face with the system. These problems include things that slowed down the processes and those that do not work well, such as unnecessary mistakes and security issues. The CNIS, as a progressive web application (PWA), was going to be a system that people could use on any device with an Internet connection. It would be something that stakeholders could use on a computer or a mobile phone. When the CNIS worked properly, the BHWs could use it to keep all their records up-to-date, which could make their work easier. The BHWs will have a way of working because the CNIS will help them do things faster and with fewer mistakes.

To pull off a formidable CNIS, the projects that were looked at revealed that the anthropometric measurements are important data entries: (1) height, (2) weight, and (3) mid-upper arm circumference (MUAC). The first two were used to compute the body mass index (BMI), and the BMI and the MUAC were then cross-referenced with sex and age to determine whether the child's BMI status is normal, obese, or undernourished. The height was also cross-referenced with sex and age to determine whether the child's growth was stunted. Other equally notable data to be encoded include medical histories (illnesses and allergies) and religious dietary preferences that would prevent these children from eating certain foods.

To achieve this personalization, the CNIS employed a combination of ”rule-based” and “knowledge-based” techniques, informed by the nutritional findings from the inputs mentioned in the previous paragraph. The former component ensured adherence to established medical and nutritional guidelines, while the latter leveraged stored health data to match needs effectively. Crucially, this functionality was tailored specifically to enable children aged 0 to 14, the demographic identified as vulnerable to malnutrition and stunting. Imagine a parent's relief upon viewing their child's growth chart presented visually. The CNIS incorporated robust reporting features that transformed complex raw data into understandable summaries. For BHWs, these digital records simplified trend analysis, allowing them to assess the efficacy of community interventions rapidly.

Ultimately, the CNIS facilitated the identification of children requiring immediate support, such as vitamin supplementation or feeding programs. By automating nutritional recommendations, the system successfully translated complex pediatric research into an operational tool for the Barangay. This shift transitioned local health management from a reactive, paper-dependent process to a proactive, digitally organized system.

PROJECT DETAILS

Overview

The proposed Community Nutrition Information System (CNIS) for Barangay San Andres, Cainta, Rizal was a progressive web application (PWA) so the system can run in both personal computers and mobile devices like smartphones and was installable using a web browser for optimal user experience (Lingolu & Dobbala, 2022; Microsoft, 2024). PWAs have innovative power because of the features of web and native mobile apps, making them ideal for modern platforms. They provided a way for users to run applications offline by caching data via the web browser's service workers, which were useful in areas with limited or no internet connectivity (Developers, n.d.; Lingolu & Dobbala, 2022). Moreover, PWAs supported push notifications to keep users informed about updates and reminders, even when the app was not open (Lingolu & Dobbala, 2022).

The CNIS has three user-role levels: (1)administrator, (2) barangay healthcare worker, and (3) parents - each of which has different access privileges. The administrator provides the initial account credentials of the barangay health workers. The administrator account is responsible for prompting general nutrition-related events.

On the other hand, the barangay health workers (BHWs) are responsible for creating the parents' initial account credentials. They are also responsible for encoding and updating the children's personal details and nutritional health data during check-ups. Meanwhile, parent users could edit the family's and children's personal details. Upon login, they were asked to change their respective passwords to ensure data security.

Project Framework

Theoretical Framework

This study was anchored in the Health Belief Model (HBM) theory as the guiding principle for the development of the proposed Community Nutrition Information System for Barangay San Andres, Cainta, Rizal. HBM explained and predicted motivation and behavior towards health based on each person's beliefs and attitudes. The diagram below was conceptualized and illustrated based on the provided explanation and insights. The theory proposed that people were more likely to take action on their health concerns if: (1)they perceived that these issues may personally put them at risk (susceptibility), (2)they believed that these health problems may lead to worse consequences (severity), (3)they understood that taking a particular step or solution to help minimize the risk or severity of illness, (4) they identified the benefits and the barriers, and evaluated that the benefits outweigh the barriers, (5) they were prompted or reminded to take actions, and (6) they were confident to take actions because they had the ability and the resources. (Ahn, Lee, & Kim, 2024; Rutter & Quine, 2002) The diagram below was conceptualized and illustrated based on the provided explanation and insights. . The theory proposed that people

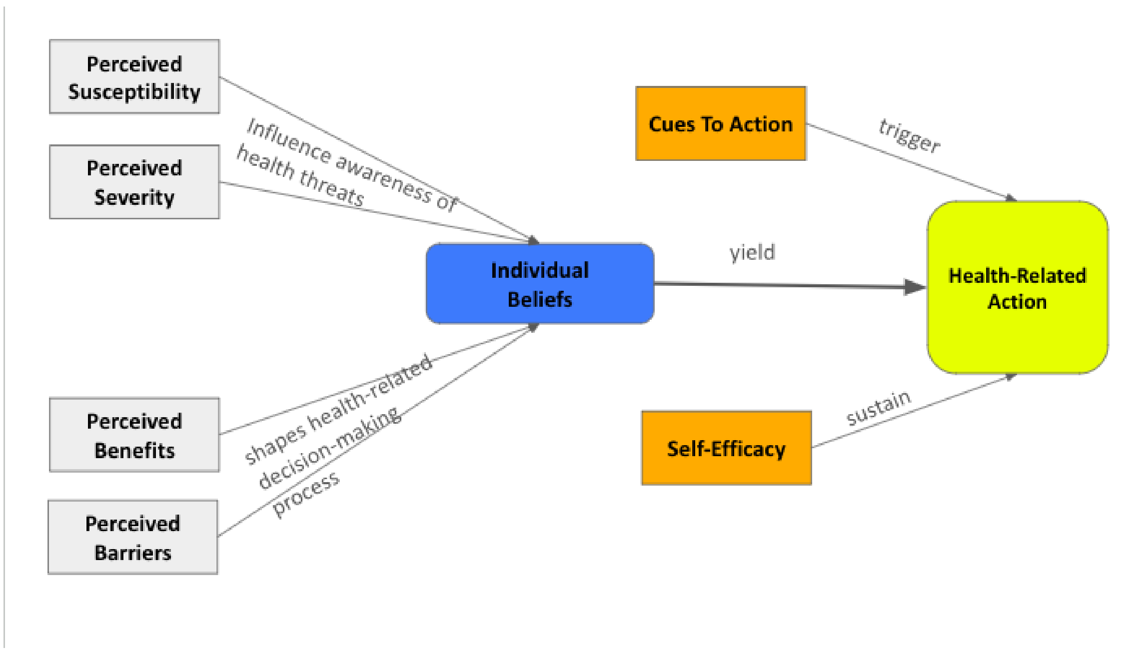


Figure 11. The Health Belief Model Theory

were more likely to take action on their health concerns if: (1)they perceived that these issues may personally put them at risk (susceptibility), (2)they believed that these health problems may lead to worse consequences (severity), (3)they understood that taking a particular step or solution to help minimize the risk or severity of illness, (4) they identified the benefits and the barriers, and evaluated that the benefits outweigh the barriers, (5) they were prompted or reminded to take actions, and (6) they were confident to take actions because they had the ability and the resources. (Boston University School of Public Health, n.d.; Glanz, Rimer, & Viswanath, 2015; Leta, 2021)

Rationale for the Framework

The Health Belief Model (HBM) was well-suited to the Community Nutrition Information System (CNIS) because it can help design interventions and communication strategies. It promoted healthy nutritional behaviors by addressing these core beliefs. It was useful in multiple studies on health-related topics, such as vaccinations, disease prevention, and patient management. This theory was a good framework for planning health programs in communities. It worked with the goals of the CNIS because of the following:

- Raise Awareness: With the CNIS giving the nutritional health status of children, BHWs and parents would become aware of those who need guidance and intervention.
- Encourage Action: The food recommendation feature would encourage the stakeholders to prepare healthier food choices and act based on the findings.
- Address Barriers: The CNIS minimized the issues of the manual system and gave an accessible alternative.
- Provide Cues to Action: It sent reminders to parents and displayed health status alerts to BHWs to enable proper, more proactive intervention.
- Boost Self-Efficacy: It helped parents feel more confident in their ability to take care of their children’s health.

Process Model

In terms of the system development, this project adapted the V-Model system development life cycle, as illustrated below:

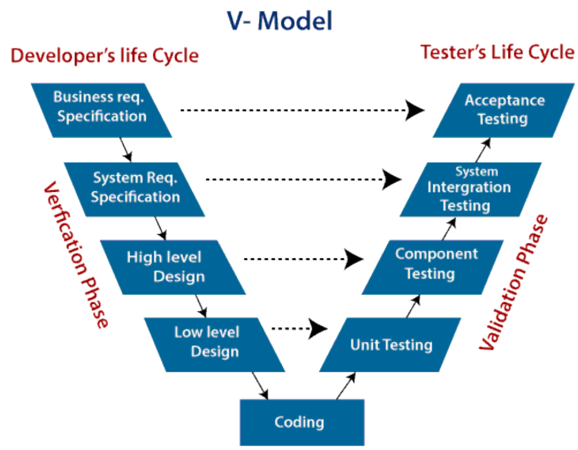


Figure 12. The V-Model Diagram

Evolved from the waterfall model, the V-Model consists of two (2) major phases: the verification and the validation. The great thing about this model is that for every development part of the verification phase, there is a corresponding testing stage under the validation phase. So, checks and balances occurred at every stage, which meant that testing standards were clearly defined (not just random checking) and testing processes were properly organized (Javatpoint, n.d.).

With this, detecting errors and issues in the system was early - saved more time, effort, and costs in creating projects. The V-Model requires detailed specifications of system requirements, as CNIS is heavily dependent on a clear definition of functional requirements to meet the nutritional health needs. It ensures high reliability in testing data accuracy and in securely handling sensitive data. Its phases are clear and well-organized, suitable for projects with a fixed timeline.

Materials/Technologies Used

The proposed CNIS for Barangay San Andres, Cainta, Rizal, integrated the following technologies during the system development:

- XAMPP (Cross-platform, Apache server, MariaDB or MySQL, PHP, and Perl) was a free, open-source software that provided a ready-to-use local server environment, integrating Apache, PHP, and MySQL. It provided a quick setup for testing, development, and debugging PHP and MySQL functionality on web platforms, including progressive web applications (such as the proposed system), before deploying to a live server. (Apache Friends, n.d.)
- Apache (Apache HTTP Server) was an open-source web server software that handled web content, interactive processing requests from clients to the back-end logic (PHP), running PHP scripts, logging errors, user activities, and accessing patterns for system auditing and troubleshooting, securing data transmissions using SSL/TLS to support HTTPS, and handling multiple users. (Apache Software Foundation, n.d.)
- Front-end integrated HTML5, CSS3, and BOOTSTRAP5 with Vanilla JavaScript. HTML5 was the foundation of web development and enabled the provision of structured, accessible, and responsive content, even offline (via local storage), for the proposed CNIS (Mozilla Developers, n.d.; W3Schools, n.d.-c). CSS3 offered a visually appealing and user-friendly interface for better interaction between users and CNIS (Mozilla Developers, n.d.; W3Schools, n.d.-b)while BOOTSTRAP5 features a robust front-end framework to support mobile-first designs, consistent layouts, and fast development cycles, and uses an updated version of Vanilla JavaScript, which integrated jQuery libraries and commands, to write cleaner and more maintainable code, ideal for lightweight and modular PWAs (Codex, 2024; W3Schools, n.d.-a). The system used JavaScript libraries: (1) Popper.js for floating elements over the userinterface like tooltips and popovers (Popper.js, n.d.), (2) SweetAlert.js allowed cutsomization and interaction of alert boxes, action dialogs, promise-based feature

for asynchronous interactions (SweetAlert2, n.d.), and (3) Bootstrap min.js, a minified compressed version of Bootstrap JavaScript library for adding responsive, interactive elements to web pages like modals, dropdowns, tooltips, and carousels (Bootstrap, n.d.).

- Back-end - PHP was a versatile server-side scripting language, suitable for building dynamic web application functions, such as user registration, data visualization, and personalized recommendations. In addition, it interacts with the MySQL database more smoothly for secure data handling. (W3Schools, n.d.-d; Zend Technologies, 2023).

- Database - MySQL, being a widely accepted relational database management system, worked seamlessly with PHP, which could manage large datasets, like nutritional health information, for faster and more reliable data retrieval, and supported the generation of queries, reports, and data analytics. (Oracle Corporation, n.d.)

- Service Worker is one of the highlights of PWAs that handles access, caching, background synchronization, and responsive design even in offline mode - well-suited for using the CNIS when the internet connection is slow or unavailable. (Google Developers, n.d.; MDN Web Docs, n.d.)

- The food recommendations were built by incorporating locally available food items and recommendations based on the Food and Nutrition Research Institute (Food and Nutrition Research Institute, Department of Science and Technology (FNRI-DOST), 2012). They are saved in the CNIS database and generated based on the children's nutritional deficiencies, medical history, food allergies, and food restrictions. As a supplement, Open Food Facts was integrated as a food recommender application programming interface (API) to suggest dietary recommendations (food and supplements) (Open Food Facts, n.d.).

System Design

System Features

It included the following features and functionalities:

- Account Registration: The system administrator initially created account credentials for the barangay health workers, then the latter changed their respective passwords. The barangay health workers created account credentials for the parents.

- Login Page: Secured access with role-based permissions were set to ensure that only authorized users can access and manipulate data.

- Patient Registration: Comprehensive management of the child profile with CRUD functionalities was developed to store and update key nutrition data. It had the following sub-modules:

  - Patient Family Registration: Since parents and not the children themselves were the direct users, the system provided registration for their family information, especially for those who have two or more children.
  - Patient Profile Registration: This was where the personal details of each child are encoded.
  - Patient Food Restrictions Registration: Child's food restrictions were typed in here, such as food allergies or religious belief restrictions.
  - Patient Medical History Registration: Child's medical history or current diagnoses were inputted in this submodule.
  - Dietary Consumption Record: This sub-module served as the daily food intake journal of the children. The parents had the primary access to input dietary consumption records, but the health workers were given editing access as well, if the parents had no gadgets or were not trained to use this submodule.

- Checkup: This feature was for encoding the health data needed for the nutrition assessment (such as but not limited height, weight, arm circumference) and the scheduling of the next checkup. These data yielded crucial information for growth and health tracking, such as BMI monitoring and height over time (for stunted growth), based on (World Health Organization, n.d.). It also provided visual progress charts and trend analysis to highlight growth patterns.

- Nutritional Health Findings and Food Recommendations: From the checkup module, this module would pop up to display the results of the child's checkup and list the foods the child should eat based on these results.
- Alerts and Nutrition Events Notification: In this part, parents received reminders for their child's next check-up appointment and notifications of nutrition events if their children are eligible. The admin and the BHWs could also organize nutrition events, such as feeding programs or vitamin distribution for these kids.
- Data Analytics and Report Dashboard: This system displayed all patterns and trends of the kids in the CNIS. The admin could view the overall nutrition status. From these, they could produce reports to support decision-making and policymaking by barangay officials. The BHWs could view data and charts for all the children, but parents were limited to viewing reports for their own children.
- Audit Trail: The system recorded the user logs for security and easier tracking in case of information discrepancies and errors.

Use Case Diagram

This diagram shows an overview of the interaction of the target users and the proposed Community Nutrition Information System for Barangay San Andres, Cainta, Rizal. The primary actors were the system's end users, such as barangay health workers and the parents of children in the community. The administrator was the secondary actor in the system that supported the end users' requested processes.

Barangay health workers served as the primary users of the system. Their responsibilities included creating parent accounts, registering patients, recording check-up data, managing nutritional findings and food recommendations for each child, creating

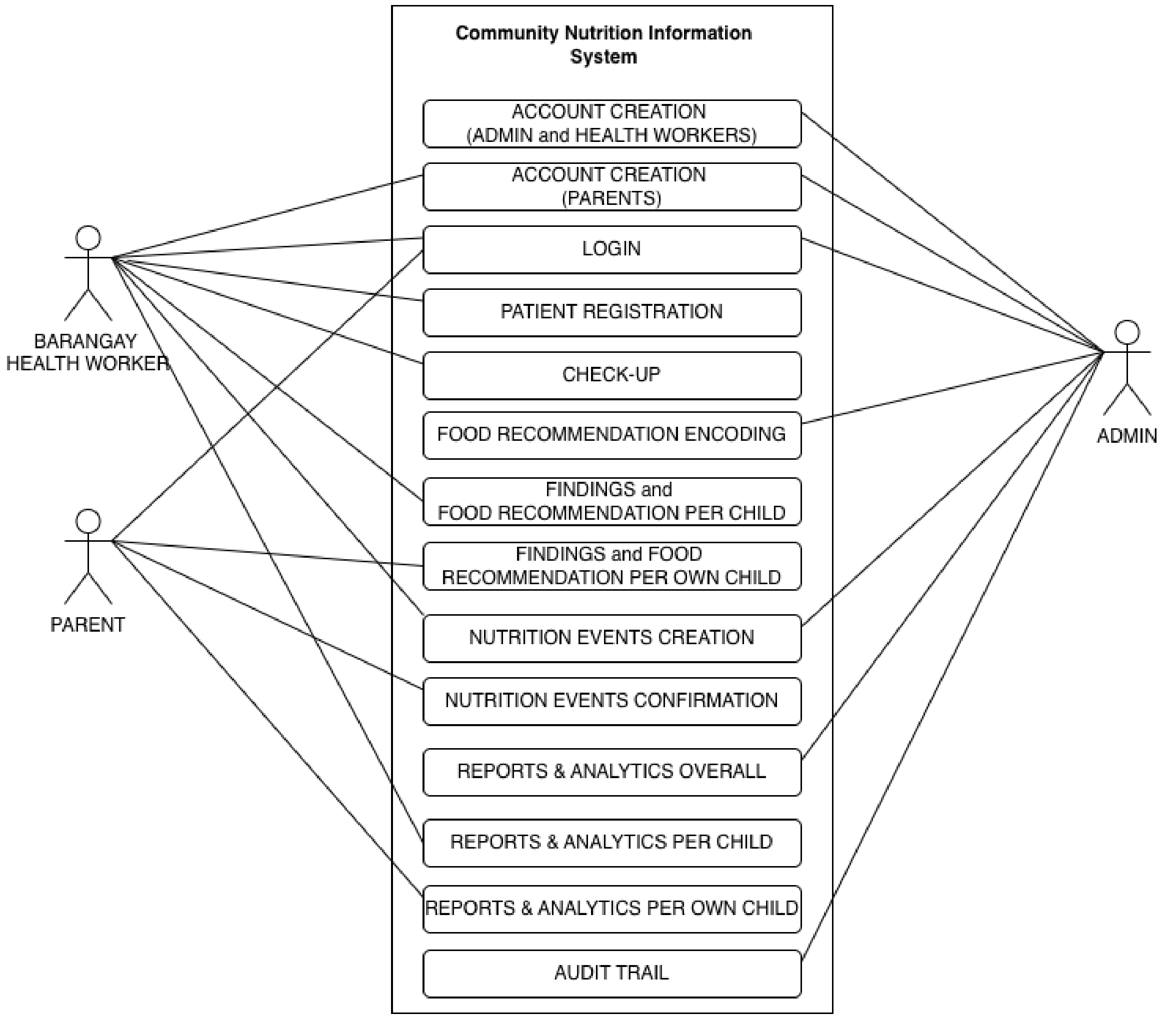


Figure 13. Use Case Diagram of the Community Nutrition Information System for Barangay San Andres, Cainta, Rizal

nutrition events, and accessing reports and analytics for individual children. On the other hand, the parents' access was limited to viewing their own children's nutritional findings and food recommendations, as well as confirming their children's participation in nutrition-related events.

The administrator was responsible for creating accounts for health workers and other administrators. Although barangay health workers primarily handled parent account creation due to their direct coordination with parents and to help distribute operational workload, the administrator could perform this function when necessary. In addition, the administrator manages food recommendations and nutrition events, monitors overall barangay-wide nutrition reports and analytics, and oversees the system audit trail.

Data Flow Diagram

The data flow diagram of the proposed CNIS for Barangay San Andres, Cainta, Rizal, illustrates how data flows through the system, including data transformation, the entities involved, the manner in which they interact with the system, and data management in data stores.

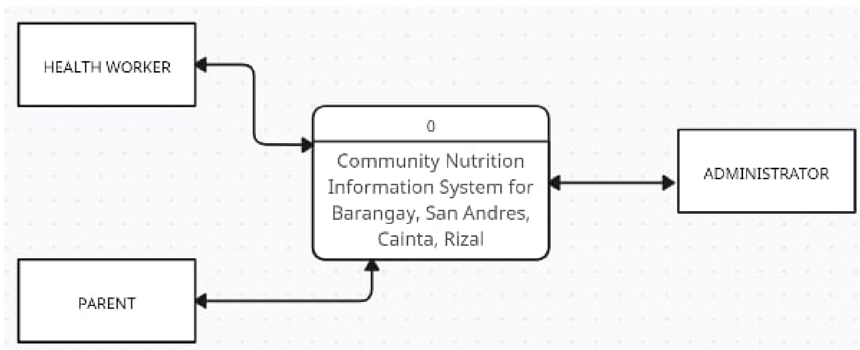


Figure 14. Context Diagram of the CNIS

The context diagram (Level 0) provided an overview of the system and its interacting entities. The proposed system had three entities, all of which sent and received information (some via notifications) into the system, as shown by the double-headed arrows. The Level 1 and Level 2 Diagrams provided additional details.

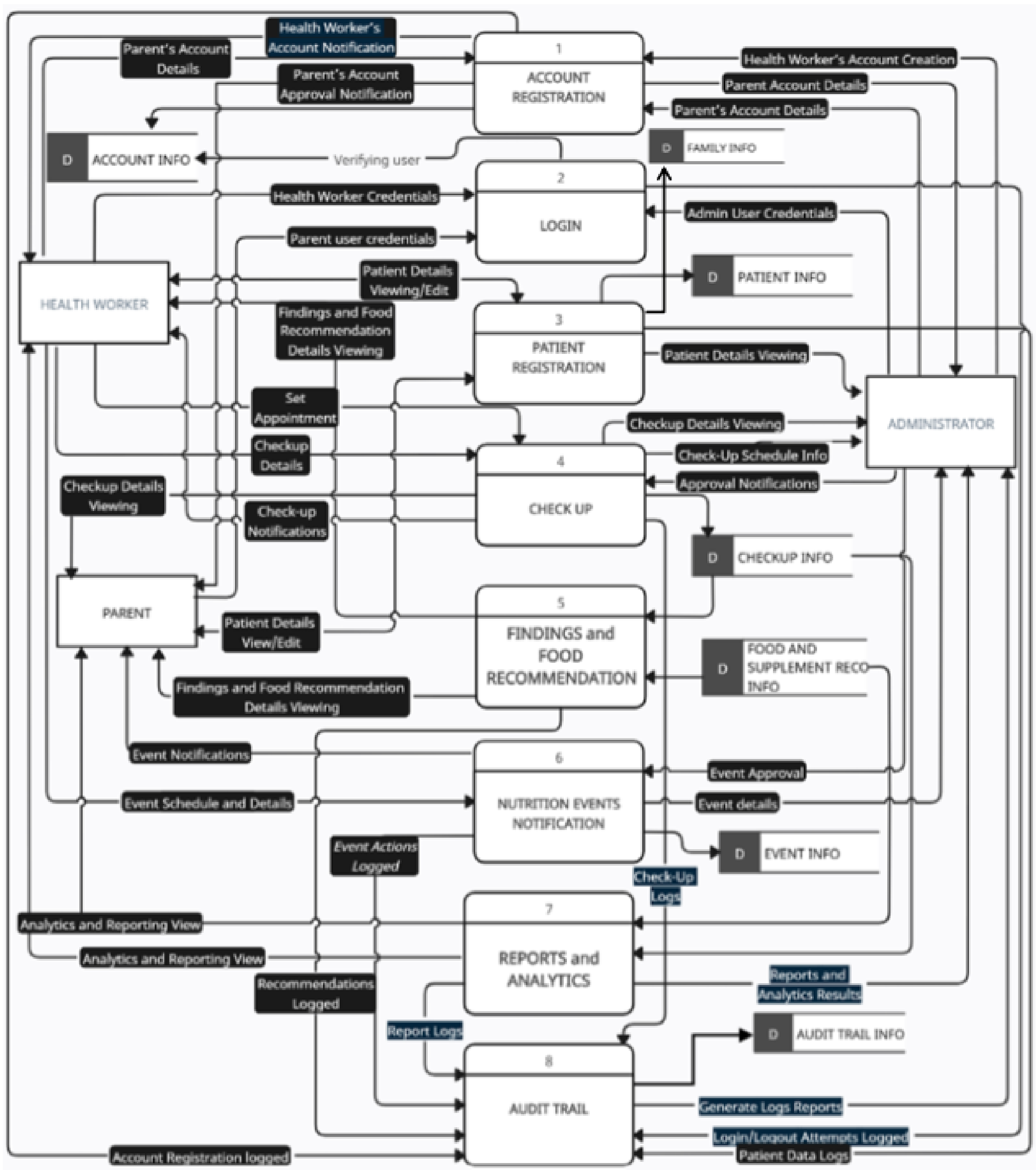


Figure 15. Data Flow Diagram Level 1 of the Proposed CNIS

Narrative Explanation of the System in the Level 1 Diagram: Account Registration and Login

1. The administrator created account credentials for the barangay health workers (BHWs).
2. The BHWs logged in to their account credentials and automatically ask them to change their passwords.
3. The BHWs created account credentials for the parents. (Alternatively, the administrator could directly create the parents' account credentials.)
4. The parents logged in to their account credentials and automatically ask them to change their passwords.

Patient Registration

1. The BHWs encoded the permanent details of the patients (children) and the nutritional health-related data. Alternatively, they could upload a spreadsheet containing previously encoded patient data for parsing and population into the proposed system.
2. The parents could edit the "mutable" data, like home address and contact information.
3. Both parents and BHWs could encode the dietary consumption records of the patients (children).

Check-up

1. The BHWs encoded the permanent details of the patients (children), the current nutritional health-related data (height, weight, etc.), and the next check-up schedule.
2. The parents and the administrator may view these records.

Findings and Food Recommendation: All three entities could view the check-up findings and food and food supplement recommendations based on the encoded check-up details and the other nutritional health-related data. Nutrition Events Notification

1. The administrator and BHWs could post nutrition events in the system for information dissemination.

2. The parents were notified and could view the upcoming nutrition events. This module also reminded these parents about their children's next check-up schedule (set by the BHWs).

Reports and Analytics

1. The administrator and BHWs could view the possible reports and analytics that CNIS has for the overall and individual information.

2. The parents could view their respective children's reports and analytics.

Audit Trail: The administrator had exclusive access to the audit trail - providing transparency, ensuring accountability, and supporting security, compliance, and troubleshooting efforts. The Patient Registration Module had a patient-family registration

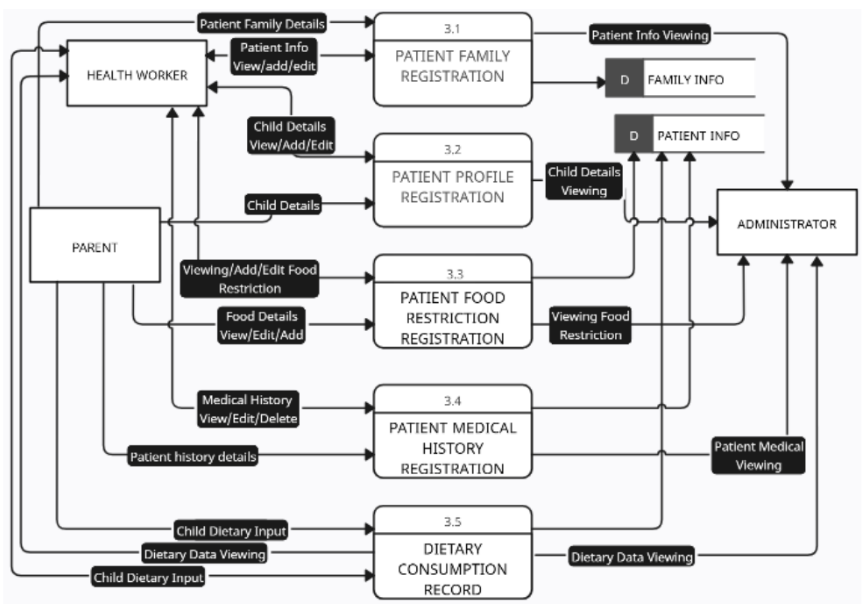


Figure 16. Sub-modules of Patient Registration Module

because the system only granted access to parents, not to the children-patients themselves. Moreover, several parents had more than one child to register in the system, so common family data were encoded in this section. The other sub-modules had the data encoded per individual child-patient data.

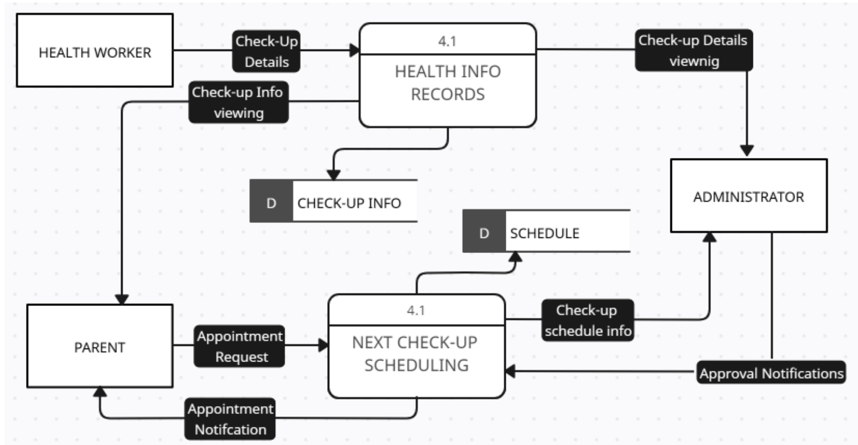


Figure 17. Sub-modules of Checkup Module

The nutritional health details from every check-up were encoded in the Health Information Recording, while the other submodule was used to set the next check-up schedule.

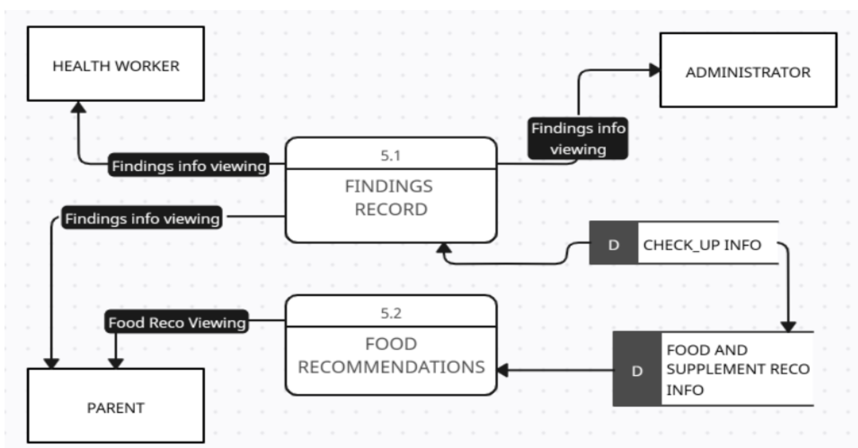


Figure 18. Sub-modules of Findings and Food Recommendation Module

The Findings Record sub-module displayed nutritional health indicators, including BMI results (severely wasted, wasted, normal, or obese) and growth status. The Food Recommendations submodule generated the report of suggested food items and supplements that the specific child-patient needs.

Database Design

Entity-Relationship Diagram

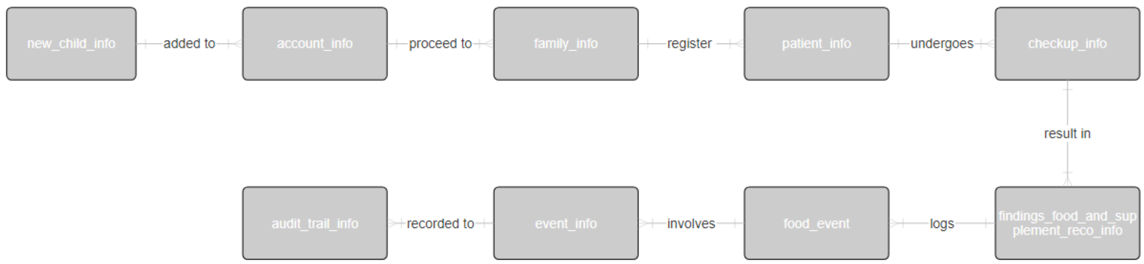


Figure 19. Entity-Relationship Diagram of the Proposed CNIS

The Community Nutrition Information System (CNIS) for Barangay San Andres, Cainta, Rizal served as the intermediary platform for monitoring and managing the nutritional health data of the young residents of the said community. Primarily, the target beneficiaries of this proposed system were children aged 0 to 14 years in Barangay San Andres to promote and maintain proper nutrition. However, since they were minors, their parents had access to the CNIS on their behalf.

Meanwhile, the barangay health workers had access to the most crucial features of the system, such as the Patient Registration and Check-up. The administrator oversaw the CNIS, created and approved account credentials, and posted general nutrition events.

Entity-Relationship Database Schema

The illustration below shows the design and contents of the database tables for the proposed Community Nutrition System for Barangay San Andres, Cainta, Rizal.

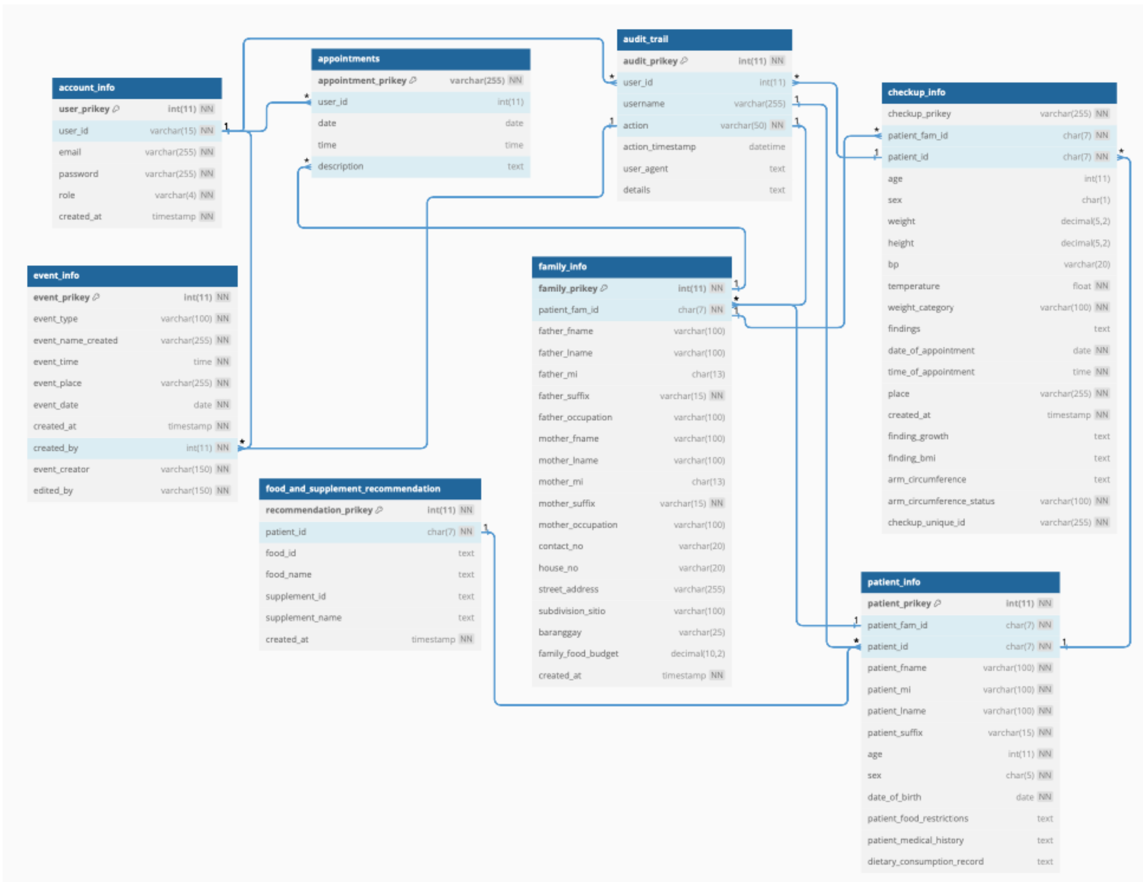


Figure 20. Database Schema Diagram for the Community Nutrition Information System for Barangay San Andres ,Cainta, Rizal

UML Diagram for Role-Based Access Control

Not all users had the right to manipulate, let alone see, sensitive information, especially health records. Therefore, Role-Based Access Control (RBAC) was a critical component of any system, ensuring users see only what they need to. The proposed CNIS implemented the role-based access control to keep the children’s personal information and nutritional health status confidential.

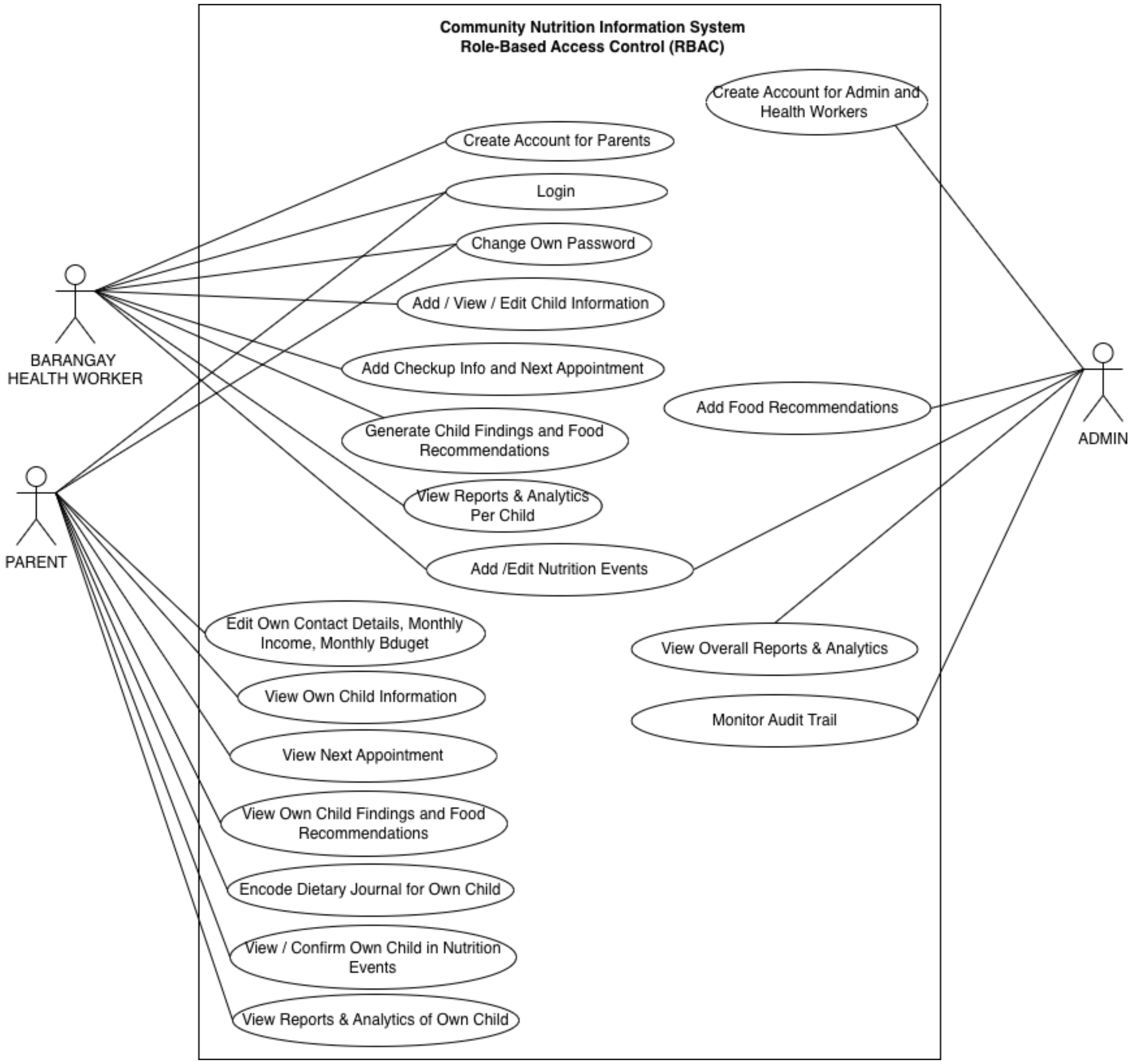


Figure 21. UML Diagram for Role-Based Access Control of the CNIS

The administrator had full privileged access, responsible for: (1) managing user accounts, system roles, and nutrition events, (2) adding new food recommendations, (3) generating the barangay-wide general reports and analytics, and (4) monitoring the audit trail.

Barangay health workers could not have the same privilege like of an administrator but they were the heaviest users of this system because they were in-charge of the most information-loaded modules: (1) registering child patients and their family profiles, (2) creating parents' accounts, (3) recording check-up stats and scheduled appointments, (4) evaluates the nutrition findings, (5) generating food recommendations, and (6) plan nutrition events.

Parents or guardians can only see things about their children. They could view nutrition results, diet recommendations, schedules, and confirm events. They can only add data in their children's dietary journal, and edit their contact details, monthly income, and food monthly budget. They need to report to the BHWs or the administrator if their personal information neeed editing (e.g. misspelled names)

Rule-Based Food Recommendation Engine

The food recommendation was the heart of the CNIS because nutrition would not be complete without suggesting healthy meal plans for the children. This proposed system would adapt the rule-based algorithm to generate the food recommendations. This technique would use the child's nutritional health findings derived from the data entries in the check-up form, including age, sex, medical history, and food restrictions, BMI status, growth status, and arm circumference status. Once these data were captured by the system, they would become the parameters or rules to identify suitable food recommendations.

The CNIS utilized a series of multiple conditional statements (explicit IF-THEN-ELSE) and keyword-based filtering to the captured rules or parameters in screening the foods and supplements that would appear as recommendations. The local foods and supplements were stored at the database and they were aligned in accordance with the guidelines of the Food and Nutrition Research Institute (FNRI), although the OpenFoodFacts API served as an external source of additional food data when needed.

Example 1: Recommendation for an Undernourished Child (Protein- and Vitamin-Rich Foods)

IF age = 6–14 years

AND BMI status = Severely Wasted

AND height status = Stunted

AND arm status = Too Small

THEN recommend → "Grilled Tilapia with Malunggay"

Example 2: Recommendation for an Obese Child (Avoiding Fatty, Oily, Sugary, and Meat-Based Foods While Recommending Vegetables, Fish, and Fruits)

IF age = 6–14 years
AND BMI status = Obese
AND height status = Normal
AND arm status = Too Big
AND no dietary restrictions detected
AND no food allergy history recorded
THEN avoid → High-fat, oily, fried, and high-sugar food items"
AND recommend → Monggo with Malunggay and Squash"

The CNIS would also perform restriction-based filtering to prevent unsuitable food suggestions. For example, a child was lactose intolerant, so the dairy-free option was ticked on the food restriction. Then, the system would block food items that contain keywords such as:

milk, cheese, yogurt, butter, cream, dairy

The filtering process evaluated food entries before generating the final list of food recommendations:

Food Item: "Monggo with Malunggay"
Result: No restricted keywords detected → INCLUDED

Food Item: "Milk Porridge"
Result: Restricted keyword "milk" detected → EXCLUDED

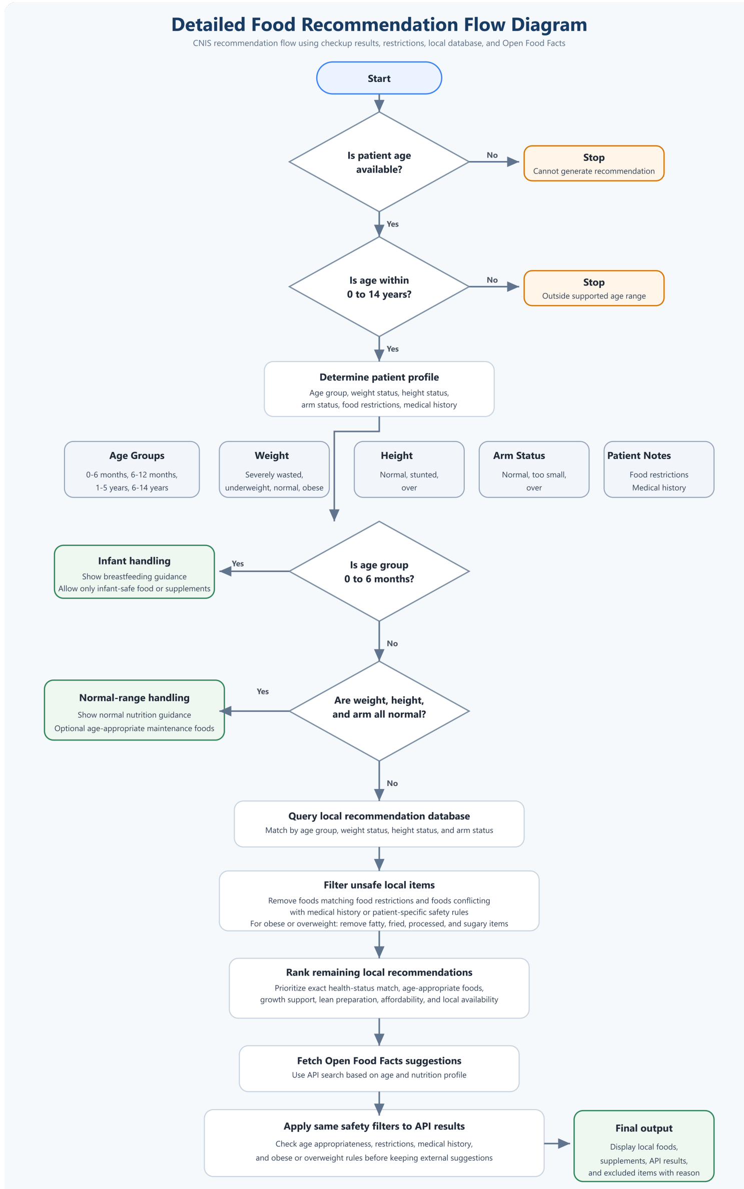


Figure 22. Rule-Based Food Recommendation Engine Workflow

Figure 22 illustrated the general workflow and decision-making process of the rule-based food recommendation engine used in the Community Nutrition Information System.

This rule-based, keyword-filtering approach helped ensure that generated food recommendations remain nutritionally appropriate, safe, and aligned with the child beneficiary's dietary conditions and restrictions.

Implementation

The proposed Community Nutrition Information System (CNIS) for Barangay San Andres, Cainta, Rizal implementation plan started in the 1st Week of October 2024. The target completion date is in the 2nd week of May 2026, ideal for children to be checked up on, given their adjusted summer vacation and the weeks ahead before the celebration of the Nutrition Month (July), when the government barangay conducts more nutritional health initiatives. It was important to note that simultaneous and overlapping activities are expected and shown in the activity list and the Gantt chart.

List of Activities

Phase 1: CNIS Project Proposal

1. Drafted a concept paper about the proposed CNIS.
2. Identified key people among the stakeholders as resource persons.
3. Conducted interviews with the key people about their insights and expectations on the progressive web app CNIS.
4. Examined pertinent documents, like check-up forms, to determine and match the data needed by the stakeholders.
5. Reviewed existing research literature and studies that are similar to this proposed project.
6. Identified the project details and assessment techniques to use.
7. Created a system prototype
8. Presented the project proposal with the system prototype.

Phase 2: CNIS Development and Implementation

1. Based on the information gathered, analyzed, and planned, matched the data and processes needed for every CNIS functionality and feature.

2. Designed the user interface, data flow, and database of the Community Nutrition Information System.

3. Implemented and tested the design using the proposed programming language and other software tools.

4. Evaluated the system by the target users, information systems, and technology professionals.

5. Launched the Community Nutrition Information System.

Project Timeline

The Gantt Chart below showed the projected timeline of the entire development cycle of the proposed Community Nutrition Information System for Barangay San Andres, Cainta, Rizal.

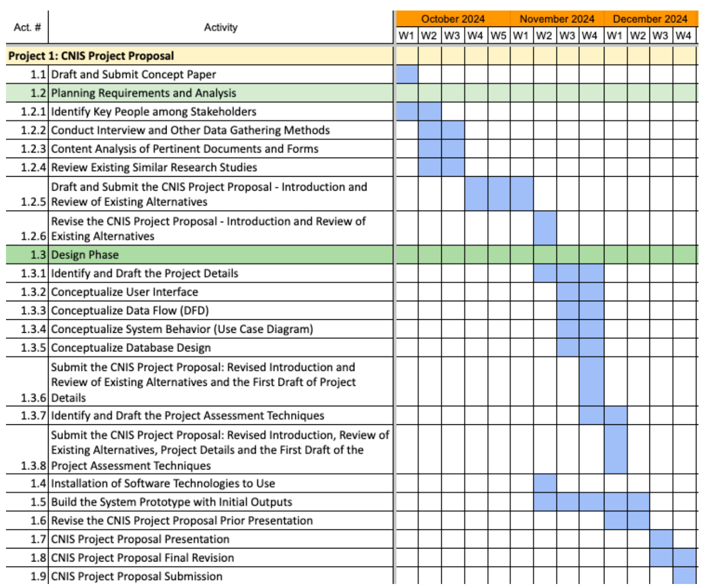


Figure 23. Timeline - Project Proposal for the CNIS

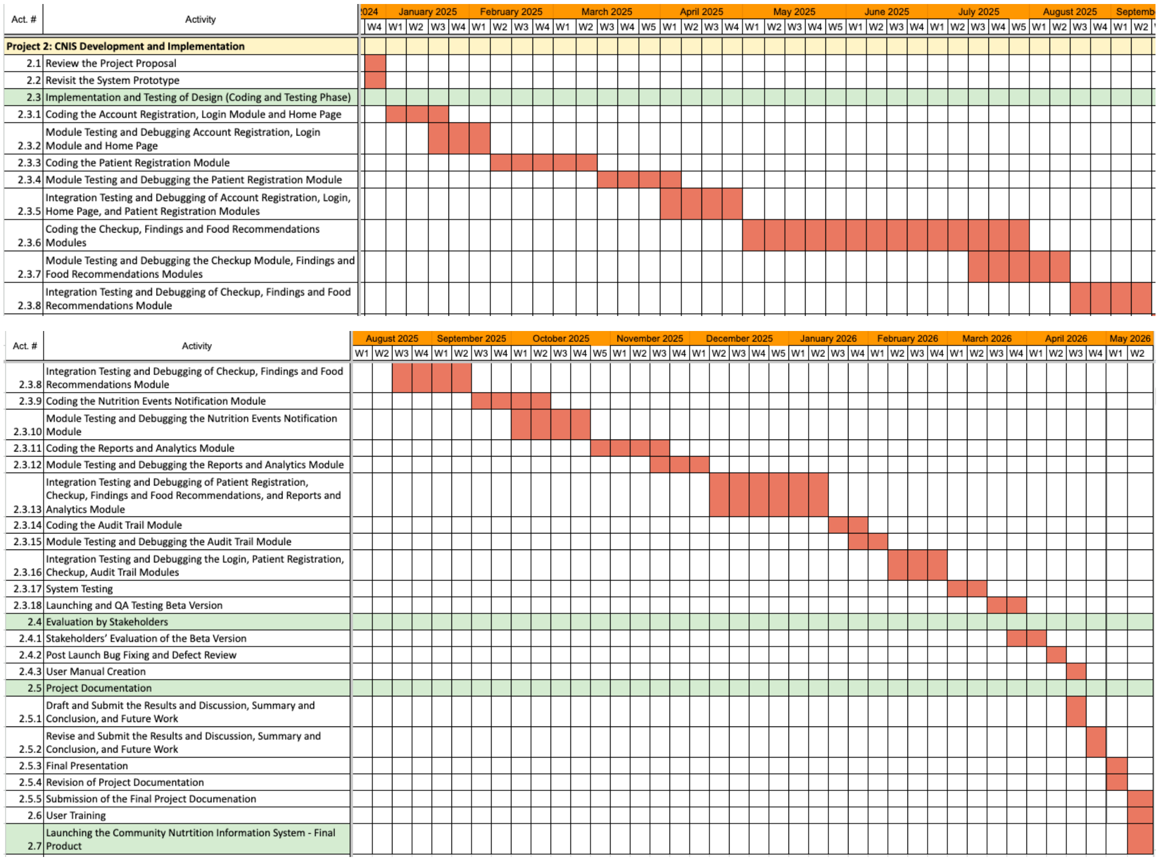


Figure 24. Timeline - Project Development and Implementation for the Proposed CNIS

Project Assessment

User Testing

The user testing of the proposed Community Nutrition Information System (CNIS) adapted the ISO 25010 Software Quality Model, which evaluates software according to nine criteria:

SOFTWARE PRODUCT QUALITY								
FUNCTIONAL SUITABILITY	PERFORMANCE EFFICIENCY	COMPATIBILITY	INTERACTION CAPABILITY	RELIABILITY	SECURITY	MAINTAINABILITY	FLEXIBILITY	SAFETY
FUNCTIONAL COMPLETENESS	TIME BEHAVIOUR	CO-EXISTENCE	APPROPRIATENESS RECOGNIZABILITY	FAULTLESSNESS	CONFIDENTIALITY	MODULARITY	ADAPTABILITY	OPERATIONAL CONSTRAINT
FUNCTIONAL CORRECTNESS	RESOURCE UTILIZATION	INTEROPERABILITY	LEARNABILITY	AVAILABILITY	INTEGRITY	REUSABILITY	SCALABILITY	RISK IDENTIFICATION
FUNCTIONAL APPROPRIATENESS	CAPACITY		OPERABILITY	FAULT TOLERANCE	NON-REPUDIATION	ANALYSABILITY	INSTALLABILITY	FAIL SAFE
			USER ERROR PROTECTION	RECOVERABILITY	ACCOUNTABILITY	MODIFIABILITY	REPLACEABILITY	HAZARD WARNING
			USER ENGAGEMENT		AUTHENTICITY	TESTABILITY		SAFE INTEGRATION
			INCLUSIVITY		RESISTANCE			
			USER ASSISTANCE					
			SELF-DESCRIPTIVENESS					
iso25000.com								

Figure 25. ISO 25010 Software Evaluation Criteria (ISO/IEC, 2011)

1. Functional Suitability: Features' correctness and completeness
2. Performance Efficiency: Response time and resource utilization
3. Compatibility: Operational with other systems and devices
4. Interaction Capability (formerly Usability): System's user-friendliness leading to user satisfaction.
5. Reliability: System stability under different conditions.
6. Security: Protection against unauthorized access.
7. Maintainability: Ease of updates and modifications.
8. Flexibility (formerly Portability): Ease of deployment on different devices and platforms.
9. Safety: Software not risky or harmful to users or their environment.

Alpha Testing

The alpha testing was conducted internally to identify issues regarding functionalities, beyond boundary cases, and compliance with ISO 25010 criteria. Here were several test case specifications used in this testing phase:

Functional Suitability

- Functional Completeness: Tested if all core features (e.g., CRUD for nutrition records, generating reports) were implemented and operational.
- Functional Correctness: Validated that computations (e.g., nutrition statistics) provided accurate results under normal and edge-case inputs.
- Functional Appropriateness: Ensured the system supported primary tasks effectively without unnecessary complexity.

Performance Efficiency

- Time Behavior: Measured system response time for common actions like saving, retrieving, and syncing data.
- Resource Utilization: Tested system performance on devices with varying hardware specifications (e.g., low-end phones).
- Capacity: Simulate multiple users accessing the system concurrently and monitor performance degradation.

Interaction Capabilities (Usability)

- Appropriateness Recognizability: Verified that menus, labels, and navigation structure are intuitive and self-explanatory.
- Learnability: Tested if users can perform tasks like adding a record or generating a report without guidance.
- Operability: Ensured all interactive elements (e.g., buttons, input fields) work as intended.

- User Error Protection: Simulated common errors (e.g., invalid data entry), checked if error messages are clear, and provided corrective suggestions.
- Accessibility: Verified the system is accessible to users with disabilities (e.g., screen reader compatibility, keyboard navigation).

Reliability

- Maturity: Checked system stability under prolonged use.
- Availability: Tested the system's ability to handle intermittent network issues (e.g., offline mode activation).
- Fault Tolerance: Simulate crashes or unexpected shutdowns and verify that data integrity is maintained.
- Recoverability: Ensured that the system can restore operations quickly after a failure (e.g., recovery of unsaved data after a crash).

Security

- Confidentiality: Confirmed that CNIS encrypted sensitive data (e.g., health records) during storage and transmission.
- Integrity: Tested if unauthorized changes to data are logged and flagged.
- Non-repudiation: Verified that the system logs all user actions accurately, with timestamps.
- Accountability: Ensured audit trails are available for sensitive transactions.
- Authenticity: Tested authentication mechanisms (e.g., secure login, password complexity enforcement).

Maintainability

- Modularity: Ensured that modules (e.g., user management, reporting) can be independently updated or replaced.

- Reusability: Confirmed that identified code components were reusable for future projects.
- Analyzability: Checked the clarity of error logs and their ability to assist developers in identifying issues.
- Modifiability: Tested the ease of adding a new feature (e.g., additional reports or APIs).
- Testability: Verified that the system supports automated or manual testing for all core functionalities.

Flexibility (Portability)

- Adaptability: Ensured the system works across browsers installed in platforms (e.g., Windows, Android, iOS).
- Installability: Tested the installation process for different platforms, especially the progressive web application (PWA) setup.
- Replaceability: Confirmed that the modules or services (e.g., APIs) can be replaced without impacting overall functionality.

Safety

- System Safety: Tested for scenarios where system actions could cause harm (e.g., accidental deletion of large datasets) and verify safeguards are in place.

All test case findings (Pass or Fail) were documented during the alpha testing. Then, all "failed" test case results were reported as bugs, including details, steps to reproduce, and severity (trivial, minor, or major). Next, major issues were resolved by debugging the code based on severity: prioritizing the major issues, then the minor and trivial bugs. After doing the unit, module, and integration tests, they should verify that the resolved codes did not introduce new bugs or errors. Lastly, regression testing was performed to verify that the code changes would not introduce new issues in the system.

Beta Testing

Beta testing using a survey was conducted with a group of target end users (health workers and parents) and several IT/IS professionals. The participant-respondents who evaluated the proposed system were as follows:

- 9 Barangay Health Workers (from the 6 health center satellites in Barangay San Andres) who were the regular end-users of the system
- 6 Parents who were direct users of the system to take their perception as non-technical users
- 6 IT Professionals assessed from a technical perspective of the CNIS, including security and performance.

The survey questionnaire for BHWs and parents focused only on the ISO 25010 software criteria and sub-criteria that have a direct impact on them, such as the user experience and the system's ability to perform its tasks:

- Functional Suitability - whether the system helped them do their work (e.g., tracking nutrition).
- Interaction Capabilities - the system must be user-friendly: easy to use, navigate, and understand.
- Performance Efficiency - speed was a critical consideration to end-users because delays or slow responses could frustrate them.
- Reliability - the system should be stable and available whenever needed.
- Security - the system should be trustworthy in terms of protecting sensitive data.

Meanwhile, the IT Professionals evaluated the proposed system from a technical perspective. The survey questionnaire covered all criteria and applicable sub-criteria defined by ISO 25010.

The survey questionnaire was drafted in Google Forms for easy access and to generate results. The name field in the survey was optional for data privacy reasons, but respondents' roles (BHWs, parents, or IT professionals) were required for proper statistical analysis.

In the survey questionnaire, the statements in the criteria and sub-criteria were phrased differently for non-technical (BHWs and parents) and technical users (IT professionals), yet remained identical in essence, to ensure both groups had a better understanding and gave a more informed evaluation of the system. Also, non-technical users were provided a Taglish version of the evaluation survey questionnaire to improve understanding. The figure below shows the sample statements on the questionnaire:

Criteria	Sub-Criteria	Questions for Non-Tech Users	Questions for Tech Users
Functional Suitability	Functional Appropriateness	The system helps me with my tasks, such as tracking child nutrition, managing accounts and events, and other transactions.	The system's functionality meets the requirements and provides appropriate results.
	Functional Accuracy	The reports and other outputs from the system are correct and useful.	The system's outputs (e.g., reports, calculations) are accurate based on the specifications.
	Functional Completeness	The system has all the features I need to complete my tasks.	The system includes all necessary features as defined in the project scope.
Interaction Capability	Appropriateness Recognizability	The system is easy to understand and use.	Different user groups can easily understand the system's purpose and functions.
	Learnability	I was able to learn how to use the system quickly.	The system is easy to learn for first-time users.
	Operability	The buttons, menus, and navigation are simple and easy to use.	The interface and workflow are intuitive for both regular and advanced users.
Reliability	Availability	The system is always available when I need it.	The system maintains expected availability levels, including during peak usage.
Performance Efficiency	Time Behavior	The system is fast enough when I use it.	The system's response times and throughput are acceptable under normal and peak loads.
Security	Confidentiality	I feel that my personal data is safe and protected in the system.	I feel that my personal data is safe and protected in the system.
	Integrity	The system prevents unauthorized changes or tampering with the data.	The system prevents unauthorized changes or tampering with the data.

Figure 26. Survey Questions Common to BHWs, Parents, and IT Professionals

Then, the IT professionals had additional questions on the other criteria and sub-criteria as illustrated below:

Criteria	Sub-Criteria	Additional Questions for Tech Users
Performance Efficiency	Resource Utilization	The system efficiently utilizes hardware, memory, and network resources.
	Capacity	The system is scalable and can handle the increasing number of users or data without performance issues.
Compatibility	Interoperability	The system integrate well with other existing systems or software (specifically the Open Food Facts API)
Reliability	Fault Tolerance	The system recovers gracefully from errors or unexpected interruptions.
	Recoverability	The system quickly recovers from failures without losing data or disrupting users.
Security	Accountability	User actions within the system can be reliably traced for accountability.
	Authenticity	The system provides robust authentication mechanisms.
Maintainability	Modularity	The system's components are designed for easy maintenance and updates.
	Reusability	Parts of the system can be reused in other applications or projects.
	Analyzability	Problems or errors within the system can be diagnosed with ease.
	Modifiability	The system can be easily modified or enhanced.
	Testability	The system is designed for thorough and easy testing.
Portability	Adaptability	The system can be used in different environments or platforms without significant changes.
	Installability	The system is easy to install on different devices or platforms.
Safety	Risk Control	The system prevents users from making mistakes that could lead to critical issues.
	User Safety	The system mitigates risks to users' data, privacy, or physical safety.

Figure 27. Additional Survey Questions to IT Professionals

All respondents used the Likert scale to assess the system against the ISO 25010 criteria and sub-criteria. It has a five-point system, with each point having a verbal interpretation:

Table 1. Five-Point Likert Scale

Scale	Verbal Interpretation
5	Strongly Agree (SA)
4	Agree (A)
3	Neutral: Neither Agree Nor Disagree (N)
2	Disagree (D)
1	Strongly Disagree (SD)

The survey questionnaire also included a space for comments on further improvements to the proposed CNIS.

For the survey questions common to the three (3) groups, Likert-scale scores were averaged within each group. These averages were combined to obtain the overall mean score for each criterion and sub-criterion.

$$\overline{X}_{\text{overall}} = \frac{\overline{X}_{\text{BHWs}} + \overline{X}_{\text{Parents}} + \overline{X}_{\text{IT Professionals}}}{\text{Total Respondent Groups}}$$

Where:

$$\overline{X}_{\text{BHWs}} = \text{Average score of Barangay Health Workers,}$$
$$\overline{X}_{\text{Parents}} = \text{Average score of Parents,}$$
$$\overline{X}_{\text{IT Professionals}} = \text{Average score of IT Professionals.}$$

For the survey questions exclusively for IT professionals, the formula was:

$$\overline{X}_{\text{IT Professionals}} = \frac{\text{Total Scores from IT Professional Respondents}}{\text{Number of IT Professional Respondents}}$$

Then, the Likert Scale Mean Range was applied to interpret respondents' average ratings across the ISO 25010 criteria and sub-criteria. It had a 5-point range system with each point range having a verbal interpretation:

Table 2. Five-Point Likert Scale for Mean Range

Mean Range	Verbal Interpretation
4.50 - 5.00	Strongly Agree (SA)
3.50 - 4.49	Agree (A)
2.50 - 3.49	Neutral: Neither Agree Nor Disagree (N)
1.50 - 2.49	Disagree (D)
1.00 - 1.49	Strongly Disagree (SD)

The proposed system should have an assessment score of 3.50 (Agree) or higher in each criterion and sub-criterion to ensure its viability upon implementation.

Accessibility Testing

The system would undergo testing using automated online tools approved by the Web Content Accessibility Guidelines (WCAG) 2.2. Here, the usability and accessibility of the system's interface, including color contrast, alternative text, and semantic structures, were assessed. The online accessibility checker asked for the CNIS URL to conduct the test. WCAG 2.2 wanted to ensure that the system is perceivable, operable, understandable, and robust. The passing score for WCAG 2.2 was between 90% and 100%, aligning with the Level AA standards (World Wide Web Consortium (World Wide Web Consortium (W3C), 2024).

Security Testing

The CNIS was set online and would store sensitive information, such as nutrition and health records. So, security testing should be done to evaluate if the encoded data remains protected from unauthorized access and web-based attacks. To conduct security testing, OWASP Zed Attack Proxy (ZAP) was used because it is widely known, trusted, and PWA-compatible to detect vulnerabilities.

During testing, the CNIS URL was copied to the ZAP application to perform the scan. It scanned the system pages and functionality to assess the application traffic and spot security risks, such as: (1) missing security headers, (2) weak SSL configurations, (3) SQL Injection, (4) Cross-Site Scripting (XSS) vulnerabilities, and weak session management (OWASP Foundation, n.d.).

After performing the scan, it would show a vulnerability report, with color-coded flags as risk classifications - high (red), medium (orange, and low (yellow), as well as the informational / observation flag (blue) (OWASP Foundation, n.d.). Then, these risks were mitigated.

The ZAP scans, vulnerability report, and mitigation were a continuous cycle until no further risk flags were reported.

Performance and Load Testing

This project used GTmetrix for front-end performance testing, assessing CNIS load behavior and optimization level. This tool measured key performance indicators, such as loading time, total page size, the number of HTTP requests, and other performance scores, based on Google Lighthouse metrics from the user's browser perspective. Other metrics displayed included First Contentful Paint (FCP), Speed Index (SI), Largest Contentful Paint (LCP), Time to Interactive (TTI), Total Blocking Time (TBT), and cumulative layout shift (CLS), which measure loading speed and interactivity. In analyzing the results, the passing final GTmetrix grade should be B (80%) or better (GTmetrix, 2020), the FCP was not more than 0.9 second (GTmetrix, n.d.-b), the speed index was at maximum 1.30 seconds (GTmetrix, n.d.-d), the LCP was at most 1.20 seconds (GTmetrix, n.d.-c), the TTI was at 2.50 seconds or less (GTmetrix, n.d.-e), the TBT should not be greater than 150 ms (GTmetrix, n.d.-f), and the CLS score should be 0.1 or less (GTmetrix, n.d.-a).

Meanwhile, Grafana k6 was used as the load-testing tool to measure simultaneous, multi-user capacity and performance limitations (Grafana Labs, n.d.-a). It evaluated the maximum number of virtual users (VUS) that can use the CNIS concurrently without violating defined performance thresholds, such as HTTP request response time, error rate limits, and iteration duration. For this study, stable and acceptable performance is defined as an average HTTP request duration of less than 500 milliseconds under moderate load conditions, with high-percentile response times (p90–p95) ideally remaining below 1 second to ensure acceptable responsiveness under concurrent access. (LoadFocus, n.d.) Meanwhile, the average, the 90th percentile (p90), and the 95th percentile (p95) of the iteration duration should not differ too much to claim that the system is stable. (Grafana Labs, n.d.-b)

The results were favorable if the system's capacity to handle regular usage can accommodate the number of concurrent virtual users, approximately 25 users (BHWs and administrators) across six health centers, who were identified as the primary and most frequent users of the system.

RESULTS AND DISCUSSION

The concept of the Community Nutrition Information System (CNIS) as a Progressive Web Application (PWA) was essential to the users, especially the BHWs. It offered flexibility because it was built as a single application, but ran on different devices. The BHWs needed the CNIS to support offline operations so they could continue working. Thanks to the PWA's offline capabilities, the system could function, and data could be synchronized under unstable internet connectivity. During data collection, the proposed CNIS should align with BHWs' workflows and parents' informational needs. Nutrition standards and guidelines were considered from the World Health Organization (WHO), the Department of Health (DOH), and the Food and Nutrition Research Institute (FNRI). It was realized that biometric health data, including BMI, MUAC, and growth indicators, were essential inputs for the system's findings and food recommendation module.

During the system development, it integrated features such as printable reports, nutritional assessments, and food recommendations. Several challenges were encountered: (1) service workers to make the system available offline, (2) data syncing between local and cloud setups, (3) validating user inputs and outputs, (4) integrating food recommendation data, and (5) prtoecting the system from web threats and risks. Consultations were conducted to improve the system's interface, user experience and efficiency. The BHWs suggested color-coded nutritional indicators for easier tagging of findings, and IT/IS professionals suggested the bulk data import function for those health records saved in spreadsheets.

The software evaluation survey and user test case were translated to Taglish for clearer understanding of the non-technical users. All these experiences contributed to improving both the technical reliability and overall usability of the proposed CNIS.

System Screenshots

This section presents the actual interfaces of the developed Community Nutrition Information System (CNIS). The screenshots illustrate how users interact with the system during actual use, highlighting the flow of operations and the presentation of key features.

- **Account Registration:** The account registration feature was not a self-signup. Administrators could create all accounts, while BHWs could setup Parents' accounts.

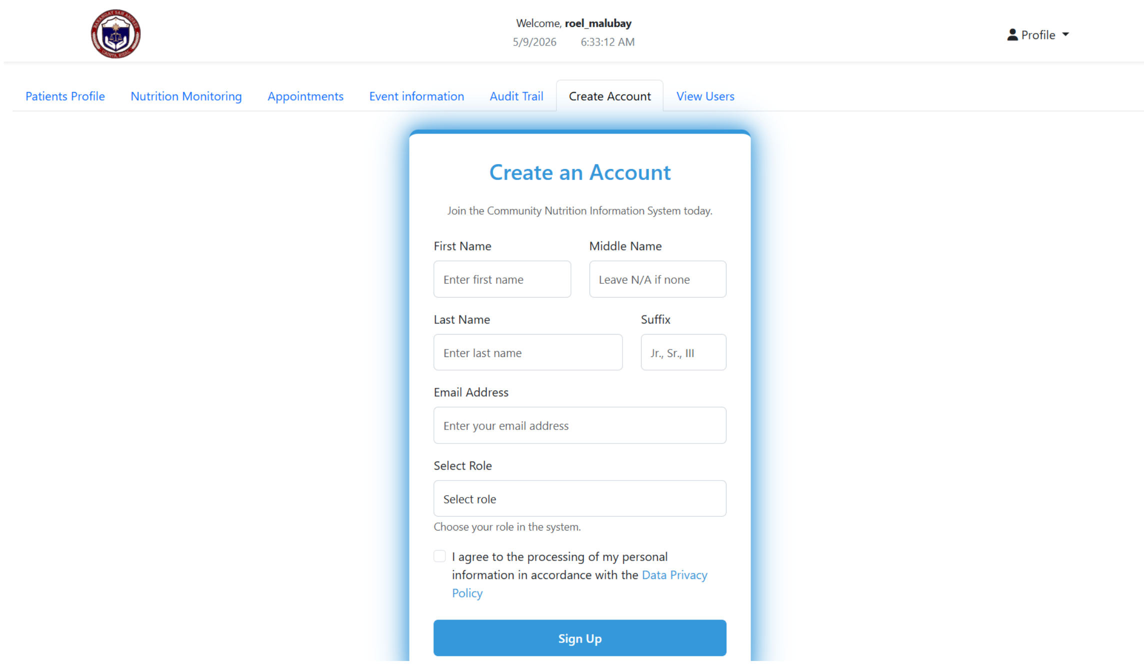


Figure 28. Account Registration Screenshot

- **Login Page:** Users should provide their credentials before accessing their respective dashboards. The role-based access control becomes evident here.

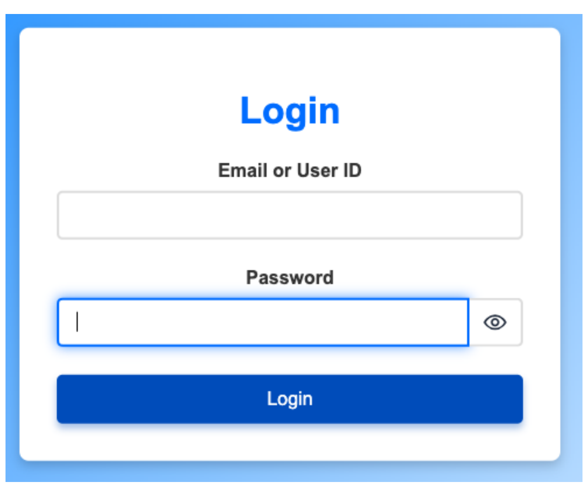


Figure 29. Login Page Screenshot

- **Patient Registration:** The patient registration module was one of the biggest modules in this system. It has several sub-modules to record and update nutritional and personal information.

  – **Patient Family Registration:** The BHWs would create parents' accounts and profiles in this sub-interface. It branched out to the Patient Profile Registration for the sake of those with multiple children.

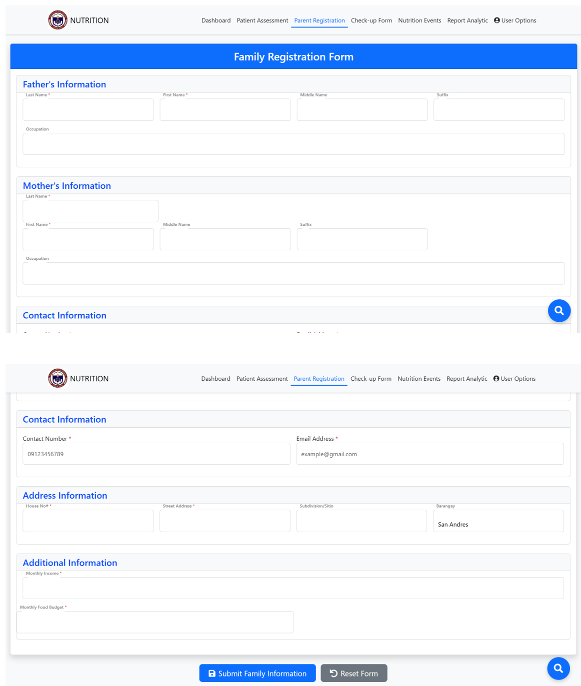


Figure 30. Patient Family Registration Screenshot

– **Patient Profile Registration:** The child's personal information were encoded here.

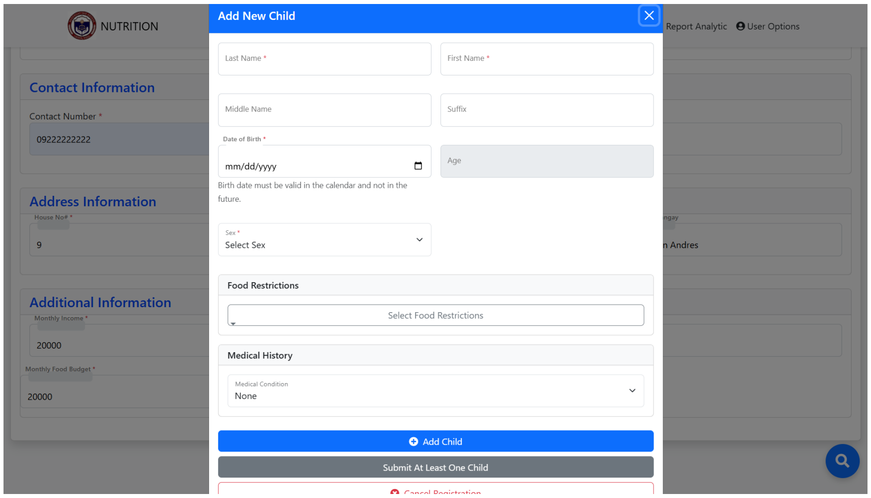


Figure 31. Patient Profile Registration Screenshot

– **Patient Food Restrictions Registration:** Food Restrictions pertaining to allergies, medical conditions, and religious beliefs were ticked in this interface.

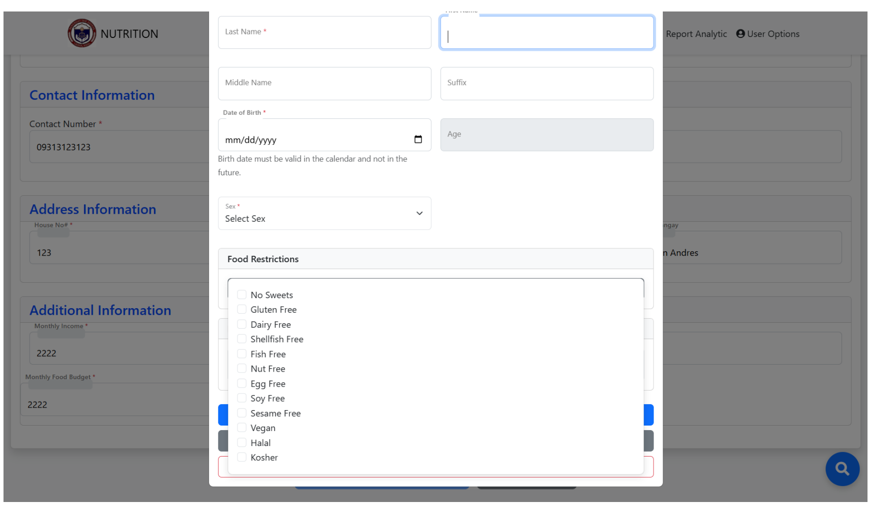


Figure 32. Patient Food Restrictions Registration Screenshot

– **Patient Medical History Registration:** The medical history section presented previously recorded conditions and diagnoses. The BHWs can just check all the options that apply to the child's condition.

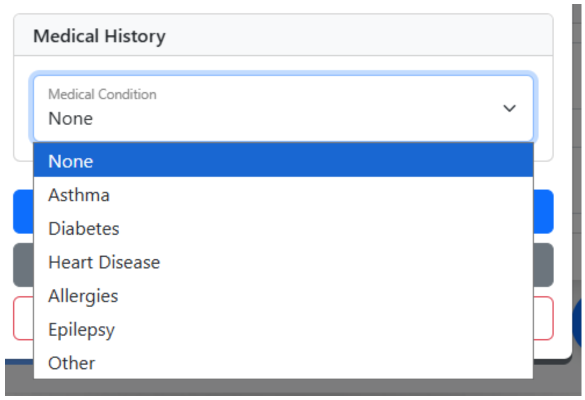


Figure 33. Patient Medical History Registration Screenshot

– **Dietary Consumption Record:** Parents and BHWs shared access here, so they can monitor the eating habits of the children.

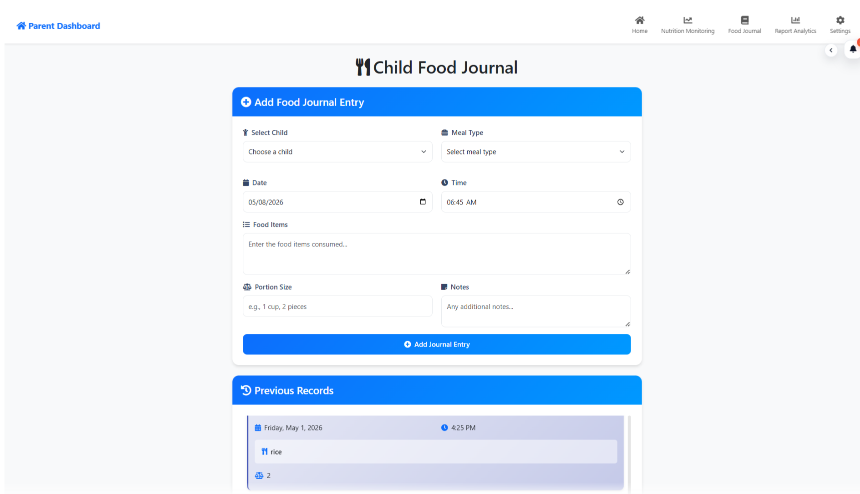
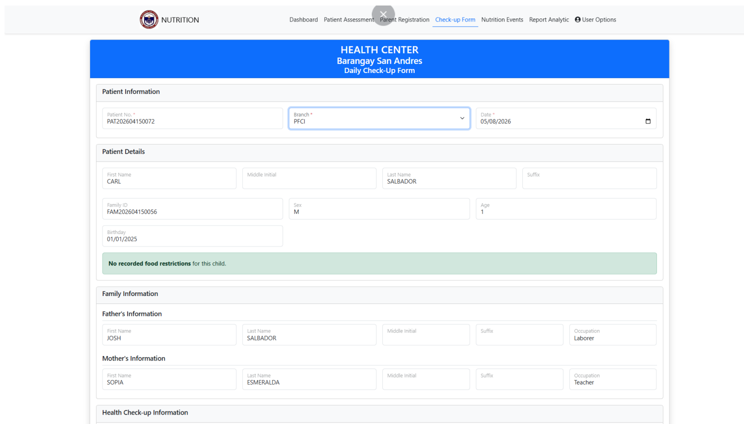


Figure 34. Dietary Consumption Record Screenshot

- **Checkup:** This virtual form captured required nutritional health data and updated them over time. The system organized these inputs into nutritional findings and charts to observe growth patterns and monitor changes in nutritional indicators visually.



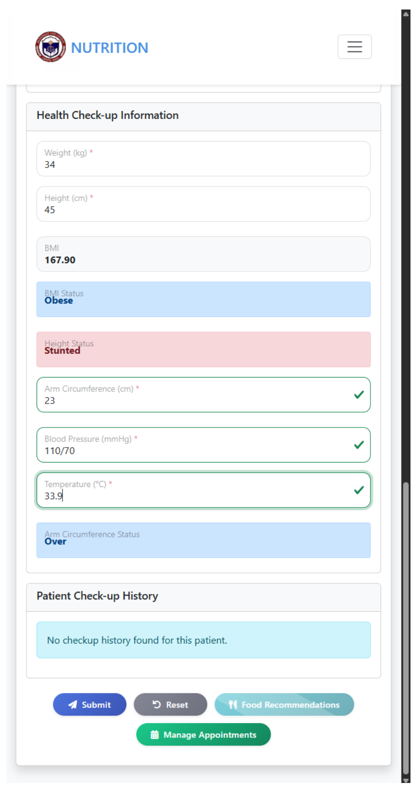


Figure 35. Checkup Form Screenshot

- **Nutritional Health Findings and Food Recommendations:** It was a pop up modal displaying the interpreted results of the recorded health data. It had the child's nutritional condition alongside suggested food recommendations that BHWs and parents could view.

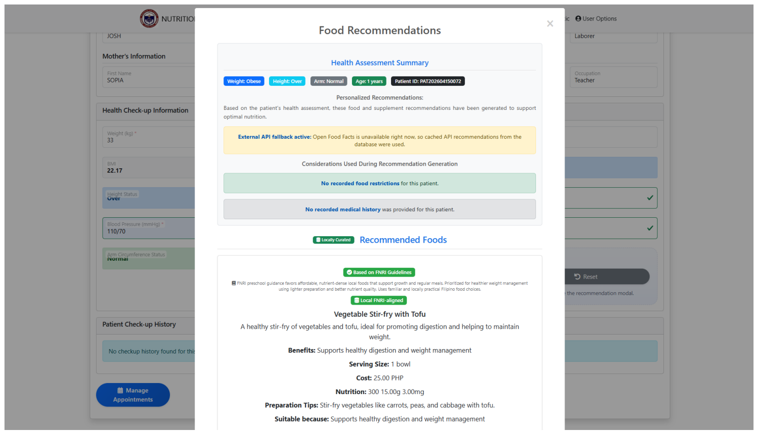


Figure 36. Nutritional Health Findings and Food Recommendations Screenshot

- **Alerts and Nutrition Events Notification:** The notification interface reflected how the system supports timely communication. It provided reminders and announcements to ensure continuous monitoring and participation in health-related activities.

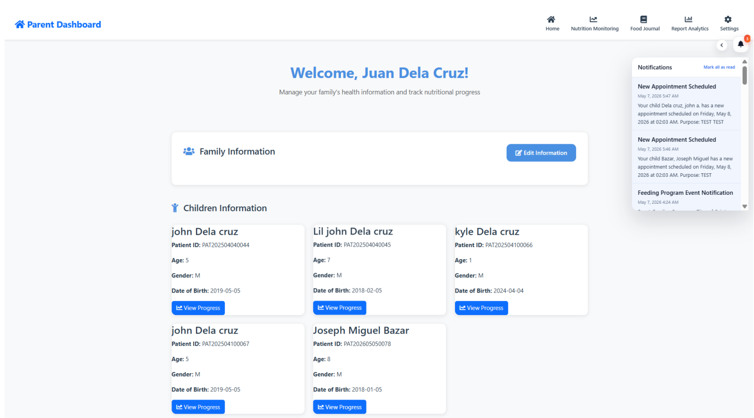


Figure 37. Alerts and Nutrition Events Notification Screenshot

- **Data Analytics and Report Dashboard:** The administrator had access to the overall nutritional health status of the community. The BHWs could see the individual health stats of all the children, while the parents' could only view their own children's reports.

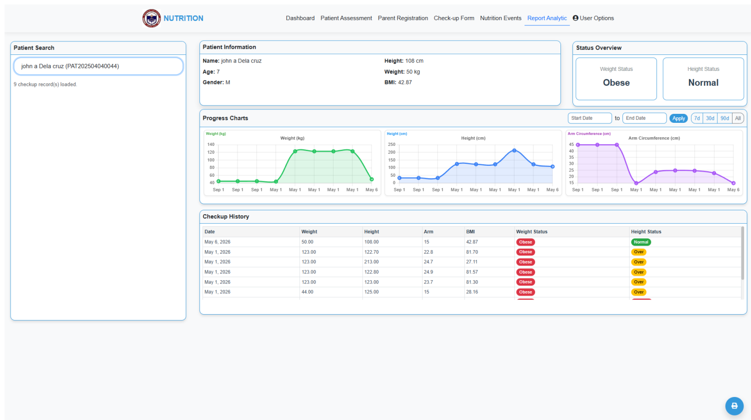


Figure 38. Data Analytics and Report Dashboard Screenshot

- **Audit Trail:** The audit trail interface recorded system activities and tracked user actions. This feature supported transparency and helped identify inconsistencies when reviewing data entries.

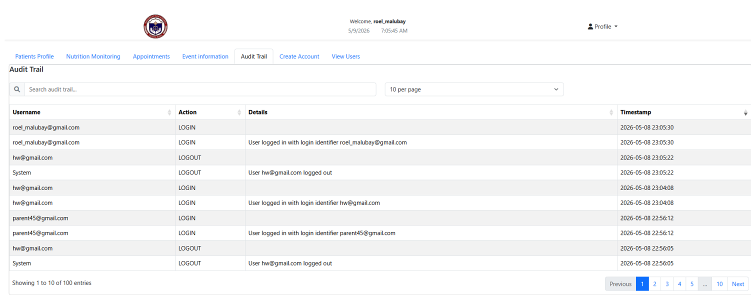


Figure 39. Audit Trail Screenshot

User Testing

As mentioned in the project assessment, there were twenty-one (21) respondents to the evaluation survey: 9 barangay health workers (BHW), 6 parents, and 6 IS/IT professionals (IS/IT). Their scores were averaged per group (mean), and the means per group were also averaged (Combined Mean) for verbal interpretation (VI) as presented in the table:

Table 3. Evaluation Survey Mean Results for All Groups

CRITERIA/SUB-CRITERIA	BHW	PARENTS	IS/IT	Combined Mean	VI
Functional Suitability					
Functional Appropriateness	4.78	4.76	4.33	4.59	SA
Functional Accuracy	4.67	4.00	4.17	4.28	A
Functional Completeness	4.89	4.17	4.33	4.46	A
Interaction Capability					
Appropriateness Recognizability	4.56	4.33	4.83	4.57	SA
Learnability	4.44	4.33	4.50	4.43	A
Operability	4.44	4.33	4.67	4.48	A
Reliability					
Availability	4.89	4.33	4.17	4.46	A
Performance Efficiency					
Time Behavior	4.56	4.33	4.50	4.46	A
Security					
Confidentiality	4.33	4.00	4.67	4.33	A
Integrity	4.11	4.17	4.83	4.37	A

Based on the results above, functional appropriateness under functional suitability and appropriateness recognizability in interaction capability received a “strongly agree” rating based on the combined mean of the respondent groups. Functional appropriateness (4.59) reflects the extent to which the CNIS supports users in completing their tasks, while appropriateness recognizability (4.57) pertains to how easily users can understand and utilize the system. The remaining sub-criteria obtained “agree” ratings, indicating generally positive user perceptions.

It was also important to note the highly positive evaluations from the barangay health workers (BHWs), who would carry the majority of the system's workload. The CNIS received the following scores from them: functional accuracy (4.67), functional completeness (4.89), availability (4.89), and time behavior (4.56) all fell within the "strongly agree" range. These results indicated that the system effectively supported the core tasks performed by BHWs while maintaining reliability and efficient response times.

Overall, the proposed system is deemed acceptable and suitable for its intended use, demonstrating satisfactory usability and functional performance in user evaluations.

Additional items were added to the IS/IT Professionals evaluation survey to assess the system further. The results were as follows:

Table 4. Evaluation Survey Mean Results for IS/IT Additional Criteria

CRITERIA/SUB-CRITERIA	IS/IT Professionals	VI
Reliability		
Fault Tolerance	4.50	SA
Recoverability	4.67	SA
Performance Efficiency		
Resource Utilization	4.67	SA
Capacity	4.33	A
Security		
Accountability	4.67	SA
Authenticity	4.50	SA
Maintainability		
Modularity	4.50	SA
Reusability	4.17	A
Analyzability	4.17	A
Modifiability	4.67	SA
Testability	5.00	SA
Portability		
Adaptability	4.17	A
Installability	4.33	A
Compatibility		
Interoperabilty	4.50	SA
Safety		
Risk Control	4.83	SA
User Safety	4.83	SA

Among the sub-criteria, testability had the highest mean (5.00) among IT/IS

Professionals, which could be perceived that they the find system design thorough and easy to test. Other sub-criteria that were rated “strongly agree” include risk control (4.83) and user safety (4.83) under safety, as well as recoverability (4.67), resource utilization (4.67), accountability (4.67), and modifiability (4.67), all of which demonstrated the reliability, efficiency, security, and ease of enhancement of the system. Additionally, fault tolerance (4.50), authenticity (4.50), modularity (4.50), and interoperability (4.50) further reinforced the system’s strong performance across core quality attributes.

The remaining sub-criteria evaluated also garnered acceptable results under the “agree” verbal interpretation. Overall, the professionals’ perceptions reflected in the findings indicate that the CNIS met established software quality standards and was considered reliable, secure, and maintainable for its intended use.

Accessibility Testing

After using the online automated accessibility checker (WCAG 2.2), the CNIS obtained an overall score of 95% and zero (0) critical issues.

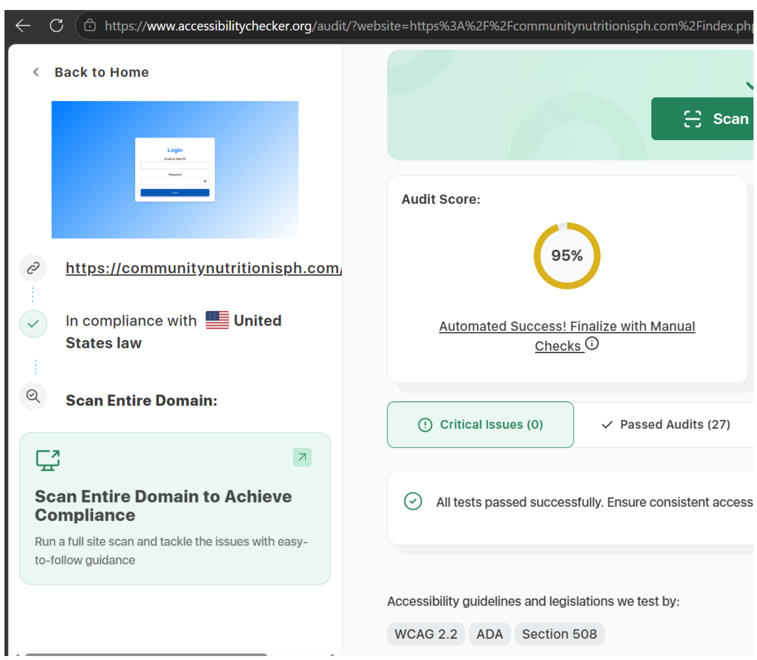


Figure 40. WCAG 2.2 Overall Result

The WCAG 2.2's passing score is at least 90%, so the system successfully met a high level of compliance with accessibility requirements. It also satisfactorily addressed most key issues related to perception, operability, understandability, and robustness.

Security Testing

During the initial scan, OWASP ZAP identified twelve (12) security vulnerabilities - seven (7) medium and (5) low. The risks were due to issues with security headers, unsafe inline scripts and styles, and the lack of enforcement of Strict-Transport-Security. The risks and mitigation steps were shown in Table 5.

Table 5. OWASP ZAP Security Findings and Mitigation Measures

Vulnerability	**Risk Level**	**Mitigation Steps**
CSP: Failure to Define Directive with No Fallback	Medium	Defined a comprehensive Content Security Policy (CSP) with appropriate fallback directives.
CSP: Wildcard Directive	Medium	Replaced wildcard (*) sources with specific trusted domains.
CSP: script-src unsafe-inline	Medium	Removed inline scripts and implemented external script files with nonce or hash-based validation.
CSP: style-src unsafe-inline	Medium	Minimized inline styles and enforced external stylesheets with proper CSP rules.
Content Security Policy Header Not Set	Medium	Configured the web server to include a strict CSP header.
Missing Anti-clickjacking Header	Medium	Implemented `X-Frame-Options` or `Content-Security-Policy: frame-ancestors` to prevent clickjacking.
Subresource Integrity Attribute Missing	Medium	Added integrity attributes to external scripts and styles to ensure resource authenticity.
Cross-Domain JavaScript Inclusion	Low	Restricted external scripts to trusted sources and reviewed third-party dependencies.
Server Leaks Information via X-Powered-By	Low	Disabled or removed the `X-Powered-By` header from server responses.
Strict-Transport-Security Header Not Set	Low	Enabled HTTP Strict Transport Security (HSTS) to enforce secure HTTPS connections.
Timestamp Disclosure (Unix)	Low	Minimized exposure of system-generated timestamps in responses.
X-Content-Type-Options Header Missing	Low	Added `X-Content-Type-Options: nosniff` header to prevent MIME-type sniffing.

After several cycles of scanning, reporting, and mitigating, the system successfully passed the ZAP security test with 0 risks.

Table 6. OWASP ZAP Informational Findings

Informational Alert	**Remarks**
Authentication Request Identified	Indicates endpoints requiring authentication were detected during scanning.
Information Disclosure - Sensitive Information in URL	Sensitive data (e.g., identifiers or parameters) exposed in URL structure.
Information Disclosure - Suspicious Comments	Source code comments could contain debugging notes or sensitive implementation details.
Modern Web Application	Confirms the application uses modern web technologies such as SPA frameworks.
Re-examine Cache-control Directives	Cache-control headers could not be properly configured, risking unintended caching of sensitive data.
Session Management Response Identified	Session handling mechanisms (cookies or tokens) were observed in responses.
User Agent Fuzzer	Server behavior varies based on different User-Agent inputs during testing.
Total Informational Flags	**7**

The only remaining alerts were informational and observation-based (blue flags), which did not pose any security threat to the CNIS but provided insights into the system behavior and areas for refinement.

In the end, the CNIS demonstrated security compliance without exploitable weaknesses remaining.

Performance and Load Testing

TThe hardware and hosting environment influenced the system's performance and load testing during deployment and evaluation. The system's responsiveness and concurrent handling depend on the device and hosting environment available.

Table 7. Minimum Client Device Specifications for CNIS Access

Component	**Specification**
Processor	Intel Core i3 (any generation) or equivalent
RAM	4 GB
Storage	500 MB free storage (browser cache and PWA offline data)
Display	1024 $\times$ 768 screen resolution
Operating System	Windows 10 / macOS 10.14 or later
Internet Connection	1 Mbps broadband connection

The client device specifications listed were the minimum requirements for accessing CNIS. It includes browser-based operations, offline caching, and data synchronization.

Table 8. Server Deployment Specifications

Component	**Specification**
Hosting Provider	Hostinger Premium Hosting
PHP Version	PHP 8.0 or later
Database	MySQL 8.0
Security	HTTPS with Let's Encrypt SSL
Storage	100 GB SSD Storage

The server-side used Hostinger Premium as the web hosting environment. Its SSD-based storage, HTTPS configuration, and PHP/MySQL compatibility contributed to efficient HTTPS request processing, managing concurrent users, and maintaining a stable web app performance during testing.

Using optimization techniques, the CNIS achieved acceptable results across all GTmetrix criteria. All values obtained from the performance metrics fell within their respective thresholds and were marked as “Good”.

These results indicate that the system achieved its enhanced responsiveness and interactivity, efficient resource page loading, and improved user experience.

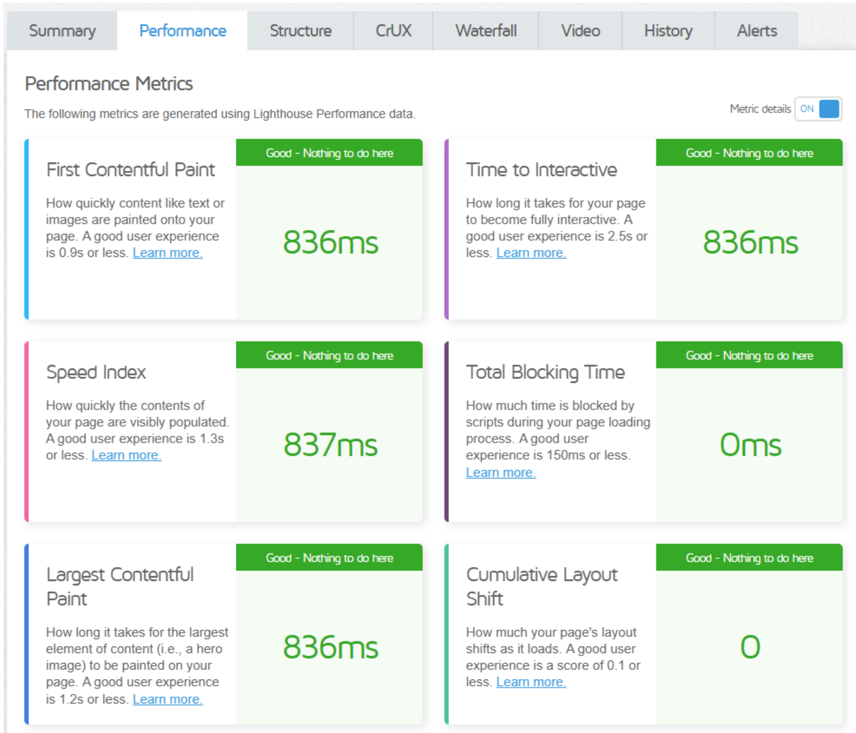


Figure 41. Final Result of Performance Metrics from GTmertix

Consequently, the CNIS received an “A” grade in GTmetrix, with 99% performance and 96% structure scores.

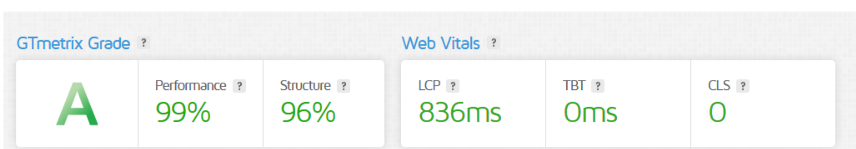


Figure 42. Overall Grade of CNIS using GTmetrix

Consequently, GTmetrix gave the system an “A” grade with 99% performance and 96% structure. It surpassed the minimum passing grade of “B” or 80%. So, based on the metrics and scores, the CNIS was considered highly performant and structurally sound as a PWA.

Table 9. k6 Performance Testing Results

Performance Metric	Statistical Measure	Value
HTTP Request Duration	Average	194.70 ms
	Minimum	47.88 ms
	Median	158.68 ms
	Maximum	1.36 s
	p90	397.80 ms
	p95	436.44 ms
HTTP Request Failure Rate	Failure Rate	0.00% (0 / 1264 requests)
HTTP Requests	Total Requests	1264 successful requests
Iteration Duration	Average	1.22 s
	Minimum	1.04 s
	Median	1.22 s
	Maximum	6.52 s
	p90	1.43 s
	p95	1.47 s
Iteration Rate	Throughput	40.77 iterations/sec
Virtual Users (VUs)	Load Level	50 concurrent users

After conducting the load testing using Grafana k6, the test scenarios were executed with 10, 30, 50, and 100 virtual concurrent users to simulate increasing system load. Table 9 included only the 50 virtual user results, as it was identified as the maximum successful load level based on the established performance thresholds.

Results under the 50 virtual users showed that the system maintained stable performance with the HTTP request duration average (194.70 ms), which is faster than the 500ms threshold, high-percentile response times (p90 and p95) are both below 1 second, and zero HTTP request failures up to 50 concurrent users. Beyond this concurrent limit, performance degraded. Meanwhile, the average, median (1.22 seconds), p90 (1.43 seconds), and p95 (1.47 seconds) of the iteration duration were close to each other, indicating the CNIS had a consistent execution time. Although the maximum iteration duration reached 6.52 seconds, it was still considered acceptable because it represented an isolated spike rather than a sustained performance issue. The recorded iteration rate of 40.77 iterations per second under a load of 50 virtual users indicates that the system sustained a high level of concurrent transaction processing. This value corresponded to approximately 0.82 iterations per second per virtual user, demonstrating that each user instance could continuously execute operations with minimal delay.

The 50-user threshold was considered acceptable because it met the expected workload of the system's primary user, comprising approximately 25 barangay health workers and administrators across multiple health centers, who would be the heaviest users of the CNIS. Meanwhile, it would still provide capacity headroom for peak usage. Overall, the findings indicated that the CNIS could reliably accommodate its expected user load without compromising system stability or request integrity.

SUMMARY AND CONCLUSION

The current study revolved around the process of designing, developing, and implementing the Community Nutrition Information System (CNIS) at Barangay San Andres, Cainta, Rizal. Its main purpose is to develop an information system that would help barangay health workers encode, manage, and analyze child nutritional information effectively, accurately, and efficiently. This system was developed as a Progressive Web Application (PWA), allowing users to access the web-based application using a service worker in their web browser even in places where the internet is spotty.

In order to fulfill its intended purpose, it was designed to make sure that it is easily understandable by users, which facilitates the easy and efficient encoding and retrieval of information such as height, weight, and mid-upper indices such as BMI, growth, and arm circumference statuses. Real-time recommendations for food items were provided based on rules and knowledge of the World Health Organization (WHO), Department of Health (DOH), and the Food and Nutrition Research Institute (FNRI). The role-based feature, printable output of results, and local recommendations for food items were included to cater to the needs of the community.

Data security and integrity were likewise considered when developing the application. Data validation processes, input limitations, and the syncing process were employed to maintain consistency and accuracy of the records. Security tests were performed using OWASP ZAP tool and resulted in a successful security test. Software quality and usability were tested via ISO 25010 software quality metrics, which consisted of surveys and test cases using barangay health workers, parents, and IT/IS specialists.

Conclusions

From the implementation and evaluation of the CNIS, the following conclusions were arrived at:

- The project was able to develop a simple yet effective CNIS for the gathering of health data using the community approach.

- The results of user testing showed a very high level of satisfaction regarding all the ISO 25010 quality attributes, such as the functionality of the software, its interactive capabilities, reliability, and performance. Functional appropriateness and recognizability attained an average score of 4.59 and 4.57 respectively, which is equivalent to “Strongly Agree”. This shows that users are satisfied with their understanding and use of the system to monitor nutrition in the community. Moreover, the health workers who were intended to use the software gave high scores (all “Strongly Agree”) regarding its functionality (4.89), availability (4.89), and time behavior (4.56).

- Also, based on the IT/IS professionals’ assessment, it can be stated that the software fulfilled criteria related to important software quality attributes such as reliability, maintainability, security, interoperability, and safety. Testability (5.00), risk management (4.83), user safety (4.83), recoverability (4.67), and accountability (4.67) rated high, which suggests that the software had been developed with stability and secure use in mind.

- Using both knowledge and rules-based approaches, the CNIS was able to conduct nutritional assessments and recommendations. The use of anthropometrics such as BMI, MUAC, and the WHO growth standards served as the basis for nutritional status assessment and diet recommendations.

- The recommendation aspect of the system was built on the basis of locally tailored references that are taken from the Nutritional Guidelines for Filipinos and Pinggang Pinoy guidelines, created by the Department of Science and Technology – Food and Nutrition Research Institute (DOST-FNRI). These references were utilized to localize the dietary recommendations of the system.

- It was proven by means of evaluations that the proposed system meets adequate standards of accessibility, safety, and performance. According to WCAG 2.2, the level of accessibility is 95%, which implies the absence of critical points of failure.

- A security assessment done using OWASP ZAP showed that the medium and low-risk vulnerabilities which were previously detected have been resolved successfully, producing no exploitable risk-level vulnerabilities.

- With regards to performance, GTmetrix awarded an “A” grade for the system, and testing performed using Grafana k6 confirmed that the system can handle up to 50 concurrent virtual users at once, without any undesirable responses and 0% request failures.

The results show that the CNIS is a viable digital system for use in barangay health and nutrition monitoring. It can help in the proper management of health data, nutritional assessments, recommendations, and can even be used by the health care workers and the parents in monitoring the children’s nutritional status in their communities.

FUTURE WORK

Despite accomplishing the major goals of the project in establishing CNIS, there are still areas which need improvement and/or addition to ensure better performance in the future. Because research and development is a continuous process, there are certain aspects of CNIS application that the developer believes could improve and optimize the functionality and scalability of the application.

1. Expanded Demographics

   In the future, it will be possible to expand the scope of CNIS from children younger than 15 years of age to include adolescents, pregnant mothers, elderly citizens, among others. There are many other demographic categories that can be included within the scope of the application in order to conduct nutritional assessments in the community.

2. Improved Data Accuracy Through Automation and Validation

   Future updates to the application will include data validation features, such as barcode scanning, biometric authentication, and voice recognition. This will make it easier for the healthcare workers to input information into the database with ease and accuracy.

3. Real-Time Synchronization and Cloud Integration

   While CNIS presently offers an offline capability, in the future, upgrades to this technology could be geared towards ensuring live synchronization of records where there is internet connection. Live synchronization would be possible through the incorporation of cloud services along with APIs for live synchronization.

4. Integration with Medical Diagnostic Systems

   The CNIS can be made more advanced and effective through its integration with electronic medical records or diagnostic systems. It will provide the correlation between the nutrition state of a person with his/her other medical conditions, thus giving the more complete picture of the health condition of the child.

5. Professional Collaboration for Dietary Recommendations

   Possible modifications in the future can imply better collaboration with nutritionists and medical professionals to make sure that the dietary recommendations provided by the program are correct, appropriate for the age of the child, and consistent with the child's actual nutritional condition. The collaboration might involve integration of features in the app allowing direct consultations with dieticians, or even the functionality allowing an AI-assisted triage, making sure that recommendations are medically justified and age-appropriate.

   Moreover, in the future versions of the app, the keyword-based filtering can be substituted by more complex criteria involving not only keywords but also such indicators of nutritional and health condition as height, weight, BMI, arm circumference, age of a child, results of nutritional diagnosis, and others.

6. Enhanced Data Privacy and Security Measures

   While the current system is subjected to security tests that are done by OWASP ZAP, there is the need to incorporate better security strategies like multifactor authentication, automatic session timeout, encryption of backups. Training modules can be developed for the user to understand data privacy.

7. Predictive Analytics and Machine Learning

   Through the incorporation of machine learning techniques, CNIS can predict future risks such as malnutrition, stunting, and fast changes in weight through prediction based on past patterns.

8. Geographic and Institutional Scalability

   As the present system operates on Barangay San Andres, it might be scaled up in future versions for other barangays, municipalities, health organizations, and even public schools. It will include scalable modules, central reporting, and comparative dashboards across multiple barangays.

Such potential advancements represent directions that this project can further explore in its research and development in the future. In tackling the above challenges, CNIS can play a more valuable role in health care administration and nutrition monitoring within communities.

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