Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

Geo-Spatial Mapping and Monitoring System of Malnutrition Trends

Reymon M. Santiañez[1*], Chiella Maryjoy D. Entero[2], Josephine C. Lomanta[3], Jhon Ricky P. Vero[4], Harvey G. Dangel[5]

[1*,2,3,4,5]Biliran Province State University, Naval, Biliran, Philippines,

***Corresponding Author:** Reymon M. Santiañez
*Email: reymonsantianez@bipsu.edu.ph

ARTICLE INFO

Received: 12 Nov 2024

Revised: 23 Dec 2024

Accepted: 10 Jan 2025

ABSTRACT

Malnutrition is a critical public health issue affecting vulnerable populations globally, including children in Biliran Province. This study aimed to develop a web-based Malnutrition Monitoring System integrated with Geospatial Mapping to provide real-time data on malnutrition cases and trends. By combining geospatial mapping technologies, the system identifies malnutrition hotspots and categorizes cases based on nutritional indicators such as weight-for-age, height-for-age, and weight-for-height. The study employed the Agile methodology within the Software Development Life Cycle (SDLC) to ensure iterative development and user-centered design. The system enables healthcare providers, including Rural Health Units (RHUs) and the Provincial Health Office (PHO), to input, track, and visualize malnutrition data through user-friendly interfaces. It also facilitates targeted interventions and informed decision-making by generating comprehensive reports on malnutrition trends. Results show that the system effectively identifies and visualizes malnutrition cases, with geospatial mapping enabling precise localization of high-risk areas. Evaluation using ISO 25010 Software Quality Standards indicated high extent as to the overall mean score of 4.0. The developed system addresses the pressing need for an advanced tool to monitor malnutrition cases in Biliran Province.

Keyword: Malnutrition, Monitoring System, Geospatial Mapping, Web-based

INTRODUCTION

Malnutrition is a state in which a deficiency of energy, protein, and other nutrition causes measurable adverse effect on the body and on growth in children (Shaughnessy & Kirkland, 2016). Geospatial mapping collects, analyzes, and visualizes geographic data to understand spatial patterns and relationships. It emphasizes the need for accurate and reliable data acquisition, covering methods such as remote sensing, GPS, and surveys, followed by data preprocessing steps, including cleaning, integration, and georeferencing (Wu et al., 2024). Geospatial mapping has become essential for public health, urban planning, and disaster management decision-making in the current technological landscape. It is helpful since it allows you to explore maps and locate health facilities, doctor to patient ratios, insect breeding grounds, locations of common diseases, and spatial population distribution for health studies (Sadiq, 2013). In addressing malnutrition, geospatial mapping identifies regions with a high risk of undernutrition and identifies possible causes (Bayu, 2019). As technology advances, integrating geospatial mapping into health monitoring systems offers new opportunities to address public health challenges, including malnutrition, with greater accuracy and impact.

The current challenge in addressing malnutrition in Biliran Province is a comprehensive and efficient monitoring system. This gap makes it challenging to track nutritional trends accurately and to identify individuals at high risk of malnutrition. With reliable data, local authorities can allocate resources effectively and make timely interventions, which worsens the malnutrition crisis in the region. According to recent statistics presented by the Biliran Provincial Health Office (PHO) in 2023, the province recorded an alarming prevalence of malnutrition among children aged 0-59 months: 4.83% were underweight, 8.67% were stunted, and 2.51% were severely stunted. Additionally, 1.98% of children were moderately wasted, and 0.58% were severely wasted. Overnutrition issues were also noted, with 1.90% of children being overweight and 1.86% classified as obese. These figures highlight the urgent need for an advanced system to monitor these conditions and provide actionable insights continuously. Such a system must make it easier to create effective policies and slow down essential actions that could save lives.

This study seeks to bridge this gap by developing a geospatial mapping-integrated malnutrition monitoring system, offering real-time data on malnutrition cases across the province. The system identifies malnutrition hotspots, enabling targeted interventions and better resource management through a web-based platform monitor and visualize malnutrition data in real-time. This system enables healthcare professionals to input data on malnutrition cases and provides comprehensive reports on trends and patterns. A vital feature of the system is its geospatial mapping, which visually represents malnutrition hotspots across different barangays in Biliran Province. This feature allows for targeted interventions, helping local authorities allocate resources more effectively to needy areas. The system design aims to enhance government agencies to address malnutrition and improve the overall health outcomes of its population. This ensures accessibility to healthcare providers at various levels, from the Rural Health Units, Department of Health, and the Provincial Health Office. The developed system help enhances public health and resource management by providing real-time data on malnutrition trends. It enables informed decision-making, efficient resource allocation, and improved community health.

Objectives of the Study

The study aims to develop a web-based application to map and monitor malnutrition cases for awareness and decision support.

Specifically, it seeks to:

1. Collect relevant data on malnutrition cases of nutritional status in terms:
   1.1. Normal;
   1.2. Underweight;
   1.3. Severely Underweight;
   1.4. Stunted;
   1.5. Severely Stunted;
   1.6. Moderately Wasted;
   1.7. Severely Wasted;
   1.8. Overweight; and
   1.9. Obesity
2. Develop a web-based application that visualize malnutrition cases based on its nutritional status and generate reports of malnutrition cases.
3. Evaluate the developed system using the ISO 25010 Software Quality Standards in terms of:
   3.1. Functionality
   3.2. Usability
   3.3. Reliability
   3.4. Efficiency
   3.5. Maintainability
   3.6. Compatibility
   3.7. Security

RELATED LITERATURE

A health condition known as malnutrition can be caused by consuming food that is either too high or too low that refers to the imbalance of in calories, carbs, vitamins, proteins, or minerals (Davis, 2020; Zhang, 2018). Dukhi (2020) added that a bodily imbalance that results in an imbalance between the nutrients the body needs and the amount it uses is the cause of malnutrition. Malnutrition can take many forms, including (1) wasting, which is defined as low weight for height. It often indicates recent weight loss due to prolonged illness and inadequate nutrition. (2) Stunting is defined as low height for age. It is caused by chronic or recurring undernutrition, typically linked to poverty, poor maternal nutrition and health, a high rate of sickness, and improper early feeding and care. Stunted children cannot develop to their full physical and mental potential. (3) Underweight is defined as low weight-for-age. An underweight child can be categorized as wasted, stunted, or both (WHO, 2024).

Malnutrition affects nations worldwide, impacting people of all ages, incomes, and genders (Global Nutrition Report, 2022). The United Nations General Assembly announced a decade of action on nutrition on April 1, 2016, to address all types of malnutrition by 2025 (Black et al., 2020). Targets for nutritional outcomes are

Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ Research Article

also set by 2030 under the Global Strategy for Women's, Children's, and Adolescents' Health, SDG-2 (end hunger, achieve food security, and enhance nutrition), and SDG-3 (guarantee healthy lifestyles and promote well-being for all ages) (World Health Organization). The World Health Organization (WHO), World Bank, and United Nations International Children's Emergency Fund (UNICEF) have all provided substantial assistance in achieving the goal of nutritional freedom, yet a world free from malnutrition remains far from being achieved (Unicef, 2019). The 2020 WHO report reveals 38.3 million overweight children, 47 million wasted, 14.3 million severely wasted, and 144 million under five with stunted growth, highlighting malnutrition's global impact.

Studies show global malnutrition prevalence varies by region due to socio-economic, cultural, and environmental factors. Adebisi et al. (2019) proved that acute malnutrition, or wasting, affects 4% of children in Uganda aged 6 to 59 months and 10% of children in the West Nile subregion. Khaliq et al. (2021) showed that in Pakistan, there is a persistently higher frequency of concurrent malnutrition forms (CFM); the occurrence of CFM was 30.6% in 2012–2013 and 21.5% in 2017–2018. Tekile et al. (2019) added that the prevalence rates for underweight, wasting, and stunting were 23.3%, 10.1%, and 38.3%. Approximately 19.47% of children were underweight and stunted, while just 3.87% of children had all three. Child malnutrition is linked to age, wealth, education, sex, family size, water, sanitation, food, and immunization (Ahmad et al., 2020). The authors conclude that malnutrition among children under five was one of the public health issues. Govender et al. (2021) added that children under five who suffer from malnutrition impact community dietary practices and cultural, social, and economic factors.

The health of the mother before, during, and after pregnancy directly impacts the nutritional condition of children, unlike adults. Maternal education, income, nutrition, child age, sanitation, family size, birth order, and birth weight are key factors in child malnutrition. Additionally, sex, social status, cooking area, fuel, breastfeeding, and caregiving behaviors significantly influence malnutrition risks (Katoch, 2022). Reduced dietary intake, malabsorption, increased nutritional losses, or changed metabolic needs can all result in malnutrition. Disease-related malnutrition is often associated with reduced dietary intake, which can be compounded in hospital patients by inadequate feeding support (Saunders & Smith, 2019). Malnutrition impacts each organ system's ability to recover and function, leading to weight loss, muscle function decline, and increased rates of morbidity. Early identification of malnutrition is crucial to prevent or reverse its negative impacts (Serón-Arbeloa et al., 2022). Luo et al. (2020) emphasized the need for improved tools like NeSNI to quantify, rank, and track multifaceted malnutrition issues globally. Rahutomo et al. (2020) developed a database for tracking children's growth, aiding healthcare interventions to achieve the national zero stunting goal.

Hawkes et al. (2020) highlighted that various policies, programs, governance systems, and funding sources oversee different malnutrition interventions. The study revealed that while undernutrition-focused initiatives have increased, they may inadvertently contribute to poor dietary choices. To address this, the research proposed a framework for developing dual-purpose strategies, integrating measures to combat all forms of malnutrition. Now that a comprehensive set of these strategies has been identified, their implementation is crucial in mitigating malnutrition's diverse manifestations. Amadou and Lawali (2022) emphasized the effectiveness of the FARN resilience program, which employs at-home learning activities for nutritional rehabilitation and dietary promotion in underdeveloped nations. The study found that the FARN program has significantly contributed to sustainable malnutrition control, highlighting the importance of community-based nutrition education. Abate et al. (2019) also stressed the need for more targeted, nutrition-specific, and sensitive interventions to enhance existing strategies. These combined efforts underscore the necessity of holistic, well-structured approaches to tackling malnutrition globally, ensuring long-term improvements in nutritional health and well-being.

Geospatial mapping plays a crucial role in tracking malnourished children and addressing malnutrition effectively. Dangermond et al. (2020) noted that since maps and Earth imagery were first digitized fifty years ago, geospatial technology has evolved significantly. Rapid advancements in information technology and changing social, economic, and environmental landscapes continue to reshape its applications. As a result, the geospatial community is continuously seeking innovative approaches to enhance mapping capabilities and address emerging challenges. Doke et al. (2021) emphasized that remote sensing (RS) and geographic information systems (GIS) have created new opportunities for accurately mapping natural resources and analyzing large geospatial datasets. Similarly, Wylie et al. (2019) highlighted the growing use of GIS and remote sensing techniques to integrate data mining and generate synoptic maps, aiding in landscape analysis and management. In healthcare, Juran et al. (2018) demonstrated how mapping techniques were used to assess hospital accessibility in 47 sub-Saharan countries. Spatial data integration on roads, land use, and elevation, they estimated travel-time metrics of 30 minutes, 1 hour, and 2 hours, showcasing the importance of geospatial mapping in healthcare planning.

Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

Malnutrition arises from an imbalance in calorie, carbohydrate, vitamin, protein, or mineral intake, leading to conditions like wasting, stunting, and underweight. Wasting results from recent weight loss due to illness or poor nutrition, while stunting, caused by chronic undernutrition, affects physical and cognitive development. Despite global efforts, malnutrition remains a critical issue, with millions of children suffering from its effects. Factors such as maternal health, education, income, sanitation, and feeding practices contribute to malnutrition. It weakens the immune system, increases disease susceptibility, and hinders overall development. Early identification and intervention are crucial in addressing malnutrition, prompting the use of databases and monitoring tools to improve healthcare responses.
Policies have expanded to combat malnutrition, but some approaches have resulted in unintended dietary consequences. Community-based nutrition programs and geospatial mapping have proven effective in tracking malnutrition trends and improving intervention planning. GIS and remote sensing enhance the accuracy of mapping malnutrition-prone areas, aiding healthcare strategies. A review of related studies highlights the need for a comprehensive system to track and manage malnutrition cases. Currently, no such system exists within the health agency sectors in the Philippines, emphasizing the importance of developing an integrated technological solution for effective malnutrition intervention.

METHODOLOGY

This study employs the standard software development life cycle (SDLC), specifically the agile method, because of its iterative and flexible approach to system development.

Figure 1 *Agile Method*

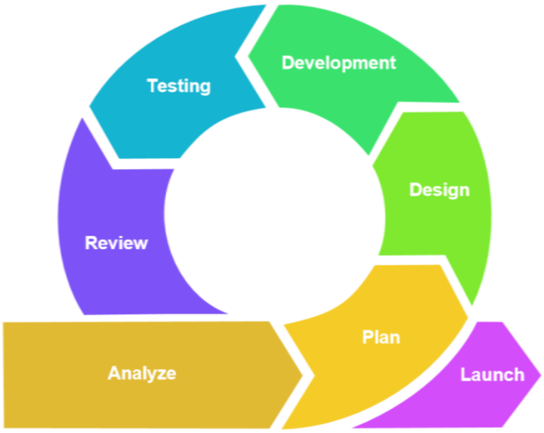


Figure 1 shows the Agile Model, a software development and life cycle (SDLC), where requirement gathering, planning, design, coding, and testing are present in the Agile process.

Analyze

In this phase the proponents defined the system's objectives, scope, target users, and data collection strategies to ensure its effectiveness in addressing malnutrition at the provincial level. The primary goal is to develop an interactive, data-driven geospatial platform that enables stakeholders to visualize, analyze, and monitor malnutrition trends, helping local government units (LGUs), public health officers, NGOs, and community health workers implement targeted interventions. The system will integrate real-time and historical data from government health records, barangay health centers, and demographic reports to provide accurate insights. It will feature geospatial mapping, and user-friendly dashboards to support data-driven decision-making. Target users include LGUs, nutrition officers, and frontline health workers, each requiring customized functionalities for data input, visualization, and reporting. By identifying reliable data sources such as the Department of Health (DOH), and Philippine Statistics Authority (PSA), the system ensures comprehensive malnutrition monitoring. This phase establishes the foundation for a strong and innovative solution that enhances malnutrition tracking, policy planning, and resource allocation, ultimately improving public health and nutrition programs in the province.

Planning Phase

This Phase ensuring that the proposed innovation tools is designed to meet the specific needs of stakeholders, particularly the Provincial Health Office (PHO) and local government agencies. During this phase, the

Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

development team engaged in consultations with key stakeholders to understand their requirements, workflows, and expectations for the system. This involved collecting detailed user needs, defining system functionalities, and determining the datasets necessary for malnutrition monitoring. Acquisition of relevant data, particularly malnutrition case records from the PHO which includes demographic profiles, health and nutrition reports, and historical malnutrition statistics to enable accurate geospatial mapping and predictive analysis. The proponents ensured that data privacy regulations were strictly followed, using the information solely for research and productivity purposes, aligning with ethical standards and client expectations. Additionally, the development team created detailed project documentation, outlining the system's scope, features, technical architecture, and security protocols. Core functionalities such as real-time data integration, interactive dashboards, automated reports, and user access controls were identified to support the needs of public health officials, NGOs, and researchers. The team also established a development timeline, specifying milestones and deliverables to ensure systematic progress. A comprehensive development roadmap was in place, providing a clear direction for building a data-driven solution to enhance malnutrition monitoring and intervention strategies at the provincial level.

Design Phase

This phase the proponents create a structured plan for the system's architecture, functionalities, and user interface. It follows an iterative design approach, breaking down the development process into smaller, manageable tasks to ensure flexibility and adaptability based on client feedback and requirements. The proponents developed system workflows, and database schemas, ensuring that the system's design aligns with the objectives set in the Planning Phase. The user interface (UI) and user experience (UX) were carefully structured to provide an intuitive and efficient platform for stakeholders such as Provincial Health Office (PHO) personnel, local government units (LGUs), nutrition officers, and health workers. The system's core functionalities include geospatial mapping, real-time data integration and monitoring, and automated reporting were prioritized based on the critical needs of these users. The modular design approach was adopted to facilitate incremental development and testing, allowing the team to integrate new features seamlessly while addressing potential challenges early in the process. Additionally, the system's technical architecture was outlined, detailing software components, security protocols, and database structures to ensure data integrity, security, and scalability.

Standardized formulas for weight for age (WFA), height for age (HFA), and weight for length/height (WFL/H) are essential tools in assessing child malnutrition. These measurements rely on Z-scores, which compare a child's measurements with a reference population.

Weight-for-Age (WFA) Formula

$$Z - score(WFA) = \frac{Child's\ Weight - Median\ Weight\ for\ Age}{Standard\ Devition\ (SD) of\ Reference\ Population} \quad (1)$$

where,

Child's Weight = refers to the actual weight of the assessed child.

Median Weight = for Age is the standard reference weight for a child of the same age based on growth charts.

Standard Deviation (SD) of Reference Population = represents the variability in weight within the reference population for that specific age group.

The weight for age (WFA) formula helps identify if a child is underweight for their age. To use this, you measure the child's weight and compare it to the average weight of healthy children from a reference population of all the same age. The formula gives a Z-score, which shows how much the child's weight differs from this average. If the Z-score is between -2 and 2, the child is considered to have an average weight for their age. However, if the Z-score is below -2, the child is underweight, and a Z-score below -3 means the child is severely malnourished.

Height-for-Age (HFA) Formula

$$Z - score(HFA) = \frac{Child's\ Weight - Median\ Weight\ for\ Age}{Standard\ Devition\ (SD) of\ Reference\ Population} \quad (2)$$

where,

Child's Height = is the actual height or length of the child being assessed.

Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

Median Height for Age = is the standard reference height for a child of the same age based on growth charts.
Standard Deviation (SD) of Reference Population = represents the variation in height within the reference population for that specific age group.

The height for age (HFA) formula is used to determine if a child is shorter than expected for their age, which may indicate stunted growth. Stunting is a sign of long-term malnutrition or poor health over a long period. To calculate this, you measure the child's height and compare it to the average height of children their age from a healthy population. The Z-score shows how different the child's height is from the average. If the Z-score is less than -2, the child is considered stunted, meaning their growth has been negatively affected over time. If the Z-score is less than -3, the child is severely stunted, which is a more severe level of long-term malnutrition.

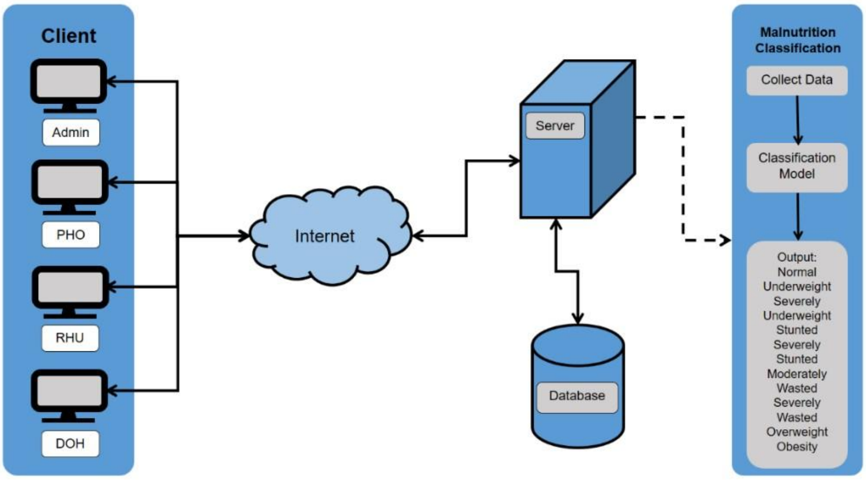
Weight-for-Length/Height (WFL/H) Formula

$$Z - score(WLH) = \frac{Child's\ Weight - Median\ Weight\ for\ Length/Height}{Standard\ Devition\ (SD) of\ Reference\ Population} \quad (3)$$

where,
Child's Weight = refers to the actual weight of the child being assessed.
Median Weight for Length/Height = is the reference weight for a child of the same length/height based on standardized growth charts.
Standard Deviation (SD) of Reference Population = represents the variation in weight within the reference population for that specific length/height group.

The weight for length/height (WLH) formula helps check if a child is too thin for their height, which indicates wasting. Wasting happens when a child loses weight quickly, often because of an illness or not getting enough food. This formula compares the child's weight to normal for children of the same height in a reference population. A Z-score between -2 and 2 means the child has an average weight for their height. If the Z-score is below -2, the child is considered wasted; if it is below -3, they are severely wasted.

Figure 2 *System Architecture*

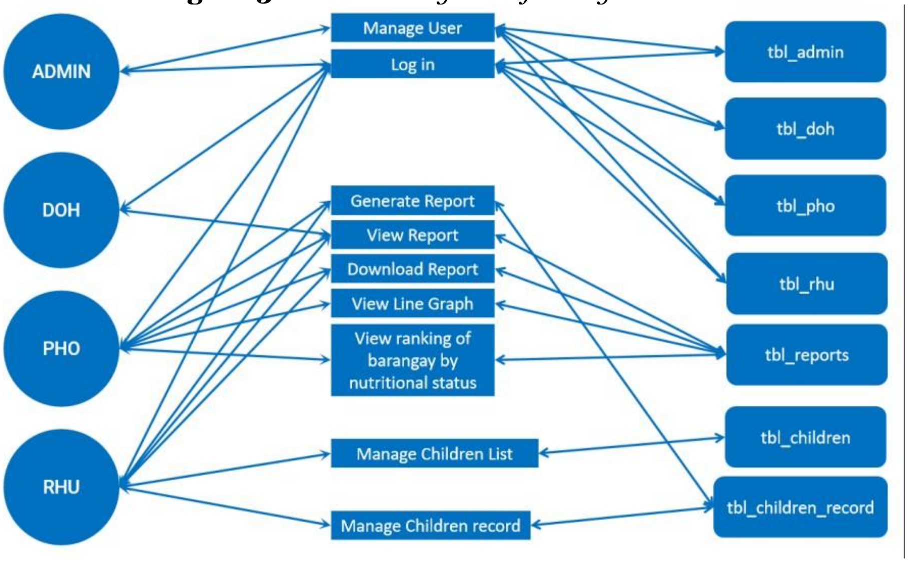


As illustrated in Figure 2, multiple users, including administrators, the Provincial Health Office (PHO), Rural Health Units (RHU), and the Department of Health (DOH), interact with the system through the Internet. The server plays a critical role in handling data exchanges between these clients and the database, ensuring seamless processing of information essential for the classification model. This model gathers relevant data and categorizes children based on their nutritional status, such as normal, underweight, or stunted. Once classified, the data is presented on a geospatial map, visually representing malnutrition trends across different regions. This mapping feature allows health authorities to efficiently track malnutrition patterns and identify areas that require immediate intervention. By utilizing this data-driven approach, health officials can develop targeted solutions to address malnutrition more effectively.
The system architecture is a graphical representation of how data moves and processes occur within the

Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

system. This diagram employs standardized symbols to denote various components, including inputs, outputs, processing steps, decision points, and connectors. Arrows link these symbols to illustrate the sequence of actions and data flow within the system. The diagram is significant in system design and analysis, providing a clear and structured overview of the process. It enables developers and stakeholders to understand the logical progression of data and identify potential areas for optimization. The architecture facilitates troubleshooting, enhances system efficiency, and supports effective decision-making by visually mapping out each step.

Figure 3 *Use Case Diagram of the System*



The figure shows the use case diagram that illustrates the functionality provided by a system in terms of users, their goals (represented as use cases), and the interactions between them. This diagram explains how users interact with the malnutrition monitoring system and geospatial mapping. It includes roles like the admin, which manages users; the DOH, which can generate and view reports; the PHO, which handles child lists and checks Barangay rankings; and the RHU, which manages children's records. The diagram also shows how these users are linked to specific tasks and data tables.

Development.

This phase the conceptualized design is transformed into a fully functional system. The design documentation, including workflows, and system architecture, is converted into source code by the team. Following the Agile methodology, the system is built iteratively, allowing continuous improvements based on testing and client feedback. Software developers begin by coding the core functionalities, such as geospatial mapping, real-time data integration and monitoring, and automated reporting. The proponents utilize appropriate programming languages, frameworks, and database technologies to ensure system efficiency, scalability, and security. The backend is developed to handle data processing and storage, while the frontend is designed to offer an intuitive and user-friendly interface for stakeholders the Provincial Health Office (PHO) personnel, Department of Health (DOH), local government units (LGUs), nutrition officers, and health workers. Through the development process, unit testing and debugging are performed to identify and resolve issues early. Moreover, iterative updates and refinements are implemented to align the system with client requirements.

Testing

This Phase plays an important role in ensuring the functionality, reliability, and accuracy of the developed system. In line with the Agile methodology, continuous integration and testing are conducted throughout the development cycle. This iterative approach allows the development team to frequently integrate new code, perform regular testing, and promptly identify and resolve issues. Multiple testing strategies are employed to maintain software quality. Unit testing ensures that individual components, such as data processing modules and mapping functionalities, work as intended. Integration testing verifies continuous interaction between different system modules, including geospatial visualization, real-time data input, and reports. Automated and manual testing methods are used to detect bugs, optimize performance, and enhance user experience. Security

Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

testing is also implemented to ensure compliance with data privacy regulations and protect sensitive health data. By maintaining a rigorous testing process, the system is continuously improved, ensuring a strong, accurate, and user-friendly platform for monitoring malnutrition trends and supporting public health interventions.

Review

This phase ensures continuous feedback from system clients, allowing stakeholders to share insights, suggest improvements, and confirm that the system meets their needs. Regular feedback loops help refine and enhance the system based on user input and evolving requirements. By incorporating stakeholder suggestions, the system remains adaptable to changing demands and industry trends. This iterative approach fosters ongoing development, ensuring the system stays relevant and effective over time. As new insights emerge, adjustments can be made promptly, improving functionality and user experience. The review process also strengthens stakeholder engagement, as clients play an active role in shaping the system's development. Their participation enhances overall system efficiency, usability, and satisfaction. Eventually, this phase promotes a dynamic, user-centered approach to system design, ensuring continuous improvements that align with real-world needs. The system evolves through regular evaluations and refinements to deliver optimal performance and long-term value.

Launch

As new features are designed and tested, the system will be deployed in phases, allowing stakeholders to access and utilize functionalities as they become available. This step-by-step rollout ensures that users can benefit from the system's capabilities early in development. By implementing an incremental deployment approach, value is continuously delivered, ensuring that improvements and enhancements are integrated efficiently. This method allows for ongoing user feedback and minimizes potential disruptions by addressing issues as they arise. Furthermore, gradual deployment ensures stakeholders can adapt to the system progressively, reducing the learning curve and facilitating smoother transitions. This approach enhances overall system stability and performance while maximizing its effectiveness in meeting user needs.

RESULTS AND DISCUSSION

The results discuss its aim, which is stated in its study objectives.

Malnutrition Data in the Province

Datasets on malnutrition cases in terms of nutritional status: normal, underweight, severely underweight, stunted, severely stunted, moderately wasted, severely wasted, overweight, and obesity from Provincial Health Office, 2024.

Table 1 ***Malnutrition Data in the Province base on WFA***

Nutritional Status	Total
Normal	119
Overweight	2
Underweight	2
Severely Underweight	1

The table shows data based on weight-for-age (WFA) where most children are in the normal range, with 119 children having a normal weight for their age. There are some cases of malnutrition, with two children identified as overweight, two children as underweight, and one child as severely underweight. It indicates that while the majority of children are growing as expected for their age, a few are either not getting enough nutrition (underweight and severely underweight) or may be consuming too much (overweight).

Table 2 ***Malnutrition Data in the Province base on HFA***

Nutritional Status	Total
Normal	109
Tall	7
Stunted	5
Severely Stunted	3

Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

Table 2 shows malnutrition datasets of children based in height-for-age (HFA), where 109 children have normal height for their age, which means they are growing as expected. However, 7 children are classified as tall. Also, 5 children are stunted, meaning they have not grown as much as they should for their age, and 3 children are severely stunted. Suggests that while most children grow well, a few experiences stunted growth due to long-term factors like poor nutrition or illness.

Table 3 ***Malnutrition Data in the Province base on WFH/H***

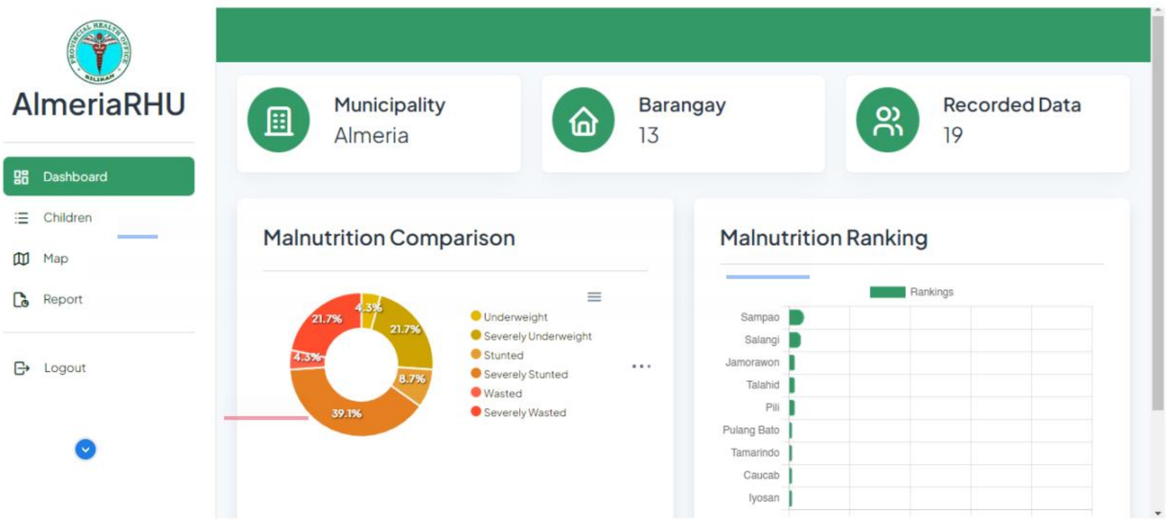
Nutritional Status	Total
Normal	121
Overweight	3
Obese	0
Wasted or Moderately Wasted	0
Severely Wasted	0

Table shows the weight-for-length/height (WFL/H), where 121 children have a normal weight for their height, which means they are neither too thin nor overweight for their height. There are 3 children are overweight, but there are no cases of obesity, wasting (being too thin), or severe wasting. It indicates that in terms of weight for height, most children are in good health.

Development of a Web Based Application

Web-based application that visualizes and reports on the malnutrition cases based on their nutritional status.

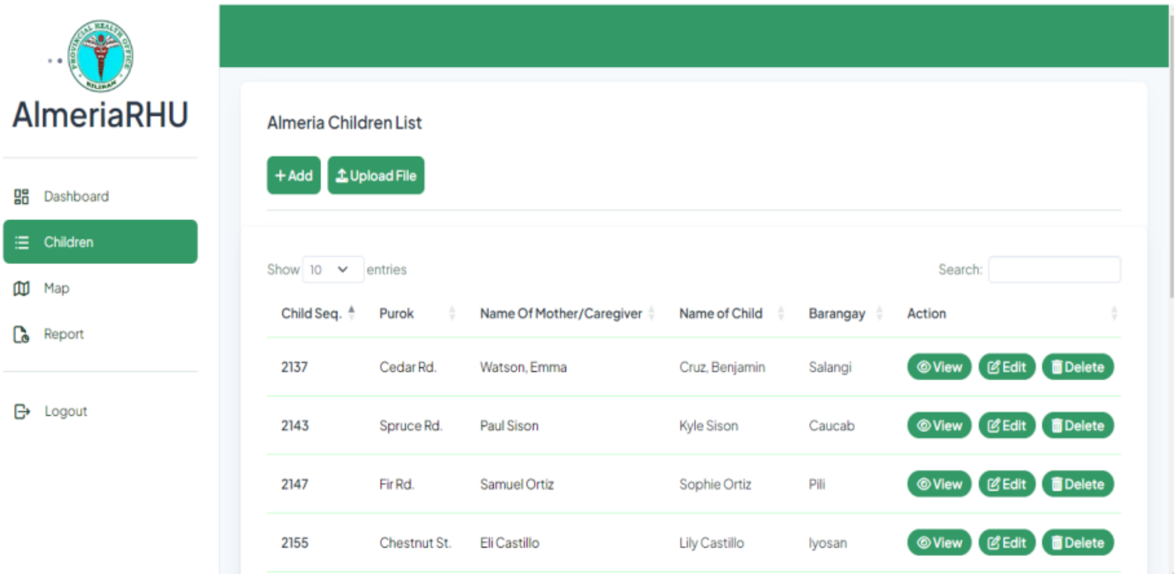
Figure 4 *RHU Dashboard Page*



The Rural Health Unit (RHU) dashboard provides a comprehensive overview of malnutrition data, equipping health officials with essential insights to monitor and address nutritional concerns effectively. This dashboard displays key statistics, enabling users to assess the overall malnutrition status within their jurisdiction. It features intuitive navigation, granting quick access to various system functions for streamlined data management and reporting. This dashboard incorporates visual representations of malnutrition trends, allowing users to analyze patterns over time. It also facilitates comparative analysis by ranking barangays based on their malnutrition status, helping officials identify high-risk areas and allocate resources accordingly. Presenting critical health data in an organized and accessible manner, the RHU dashboard enhances decision-making and supports targeted interventions to improve community nutrition and well-being.

Figure 5 *Children List for RHU*

Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**



The figure shows the list of children that are registered within the RHU system. It displays basic information like the child's name, mother's name, and Barangay. This list also allows users to quickly access and change a child's detailed profile through a view, edit, delete, and add action

Figure 6 *Children Health Report Page for RHU*

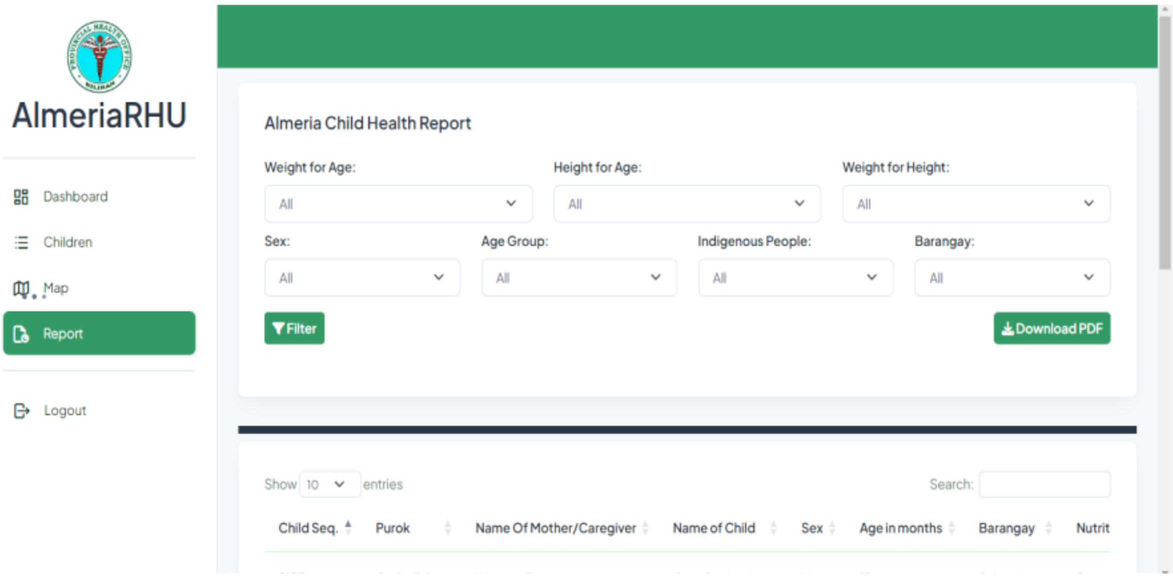


Figure 6 showcases the Child Health Report page, which allows users to filter and analyze essential health data of children based on categories such as weight, height, sex, age group, Barangay, and Indigenous community status. This feature helps health officials monitor the nutritional status of children, identify at-risk groups, and implement targeted interventions. The page presents the filtered data in a structured table, providing detailed child information for easy review and analysis. Users can also download the report for offline access and further evaluation, making it a valuable tool for program planning, policy-making, and progress tracking in child health and nutrition.

Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

Figure 7 *Map for Malnutrition Cases*

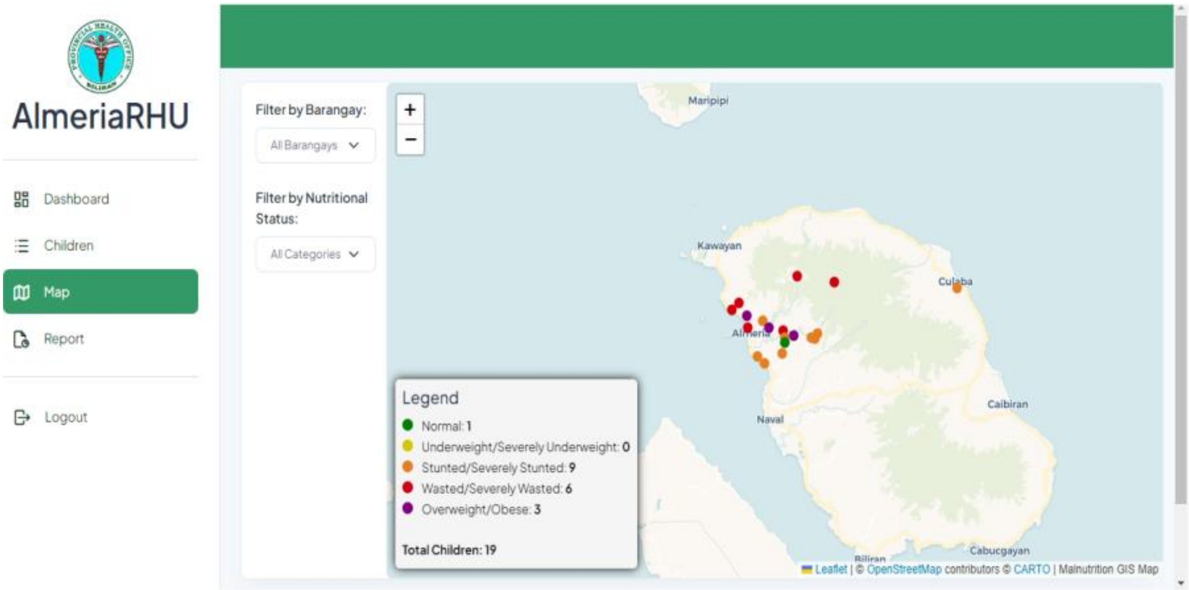
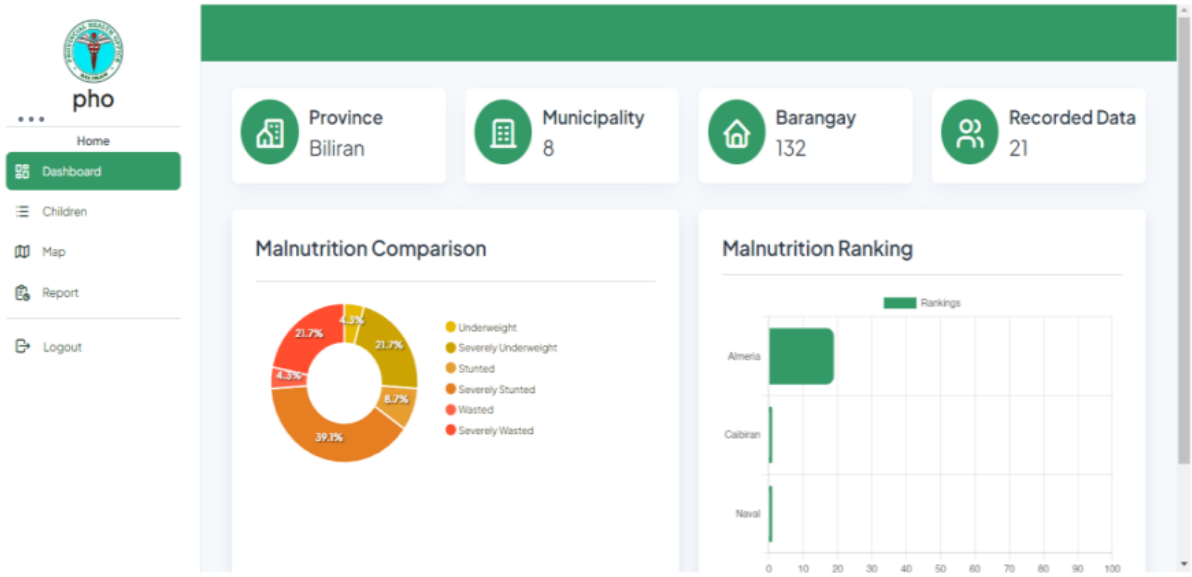


Figure 7 presents a Leaflet-based OpenStreetMap of Biliran Island, highlighting specific areas where malnutrition cases have been recorded. The map utilizes color-coded markers to indicate various types of malnutrition, with each color corresponding to a specific nutritional status as defined in the legend. This visual representation allows for a clear and intuitive understanding of malnutrition distribution across the island. Additionally, users can filter the displayed data by Barangay and malnutrition category, enabling a more focused analysis of affected areas. By applying these filters, users can pinpoint locations with higher prevalence rates, facilitating better decision-making and targeted interventions. This interactive map is a valuable tool for health officials and policymakers, allowing them to monitor malnutrition trends, allocate resources efficiently, and implement necessary measures to address nutritional deficiencies in the most affected communities.

Figure 8 *Provincial Health Office Dashboard Page*



Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

Figure 8 presents the Provincial Health Office (PHO) dashboard for monitoring and managing malnutrition data across the province. This dashboard provides provincial health officials with a comprehensive overview of key statistics, offering real-time insights into the malnutrition status of various municipalities. By consolidating essential data in a single interface, the system allows officials to identify trends, track progress, and make informed decisions to improve public health initiatives.

The dashboard features interactive elements, enabling users to navigate the different reports and data visualization. It helps health administrators assess the effectiveness of existing programs, allocate resources efficiently, and prioritize intervention efforts where they are most needed. The system ensures continuously updates data, allowing officials to respond proactively to emerging health concerns. With its user-friendly design and strategic functionalities, the PHO dashboard enhances data-driven decision-making, supporting the province's goal of reducing malnutrition and improving overall health outcomes.

Figure 9 *Dashboard Page for Admin*

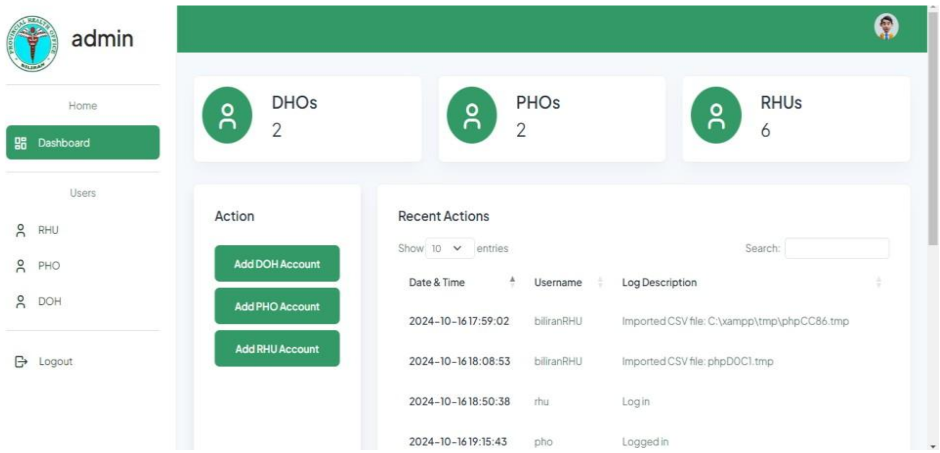
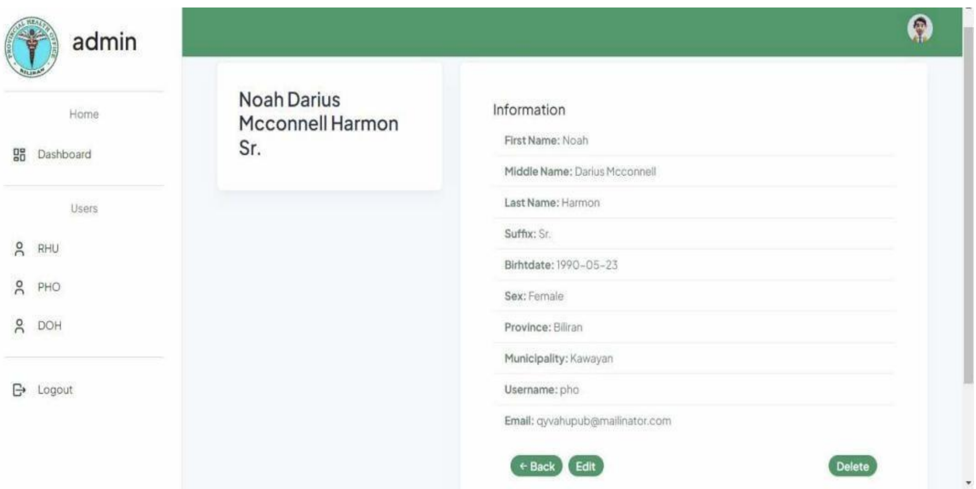


Figure 9 displays the admin dashboard, a centralized hub designed to update system management. This interface empowers administrators to efficiently oversee user accounts, monitor system performance, and maintain data accuracy. Administrators can quickly access essential tools for updating user permissions, tracking system activity, and ensuring data integrity. The dashboard serves as a center, enabling real-time decision-making and continuous system maintenance. Providing a comprehensive view of system operations enhances administrative efficiency, ensuring smooth functionality and reliable data management across the platform.

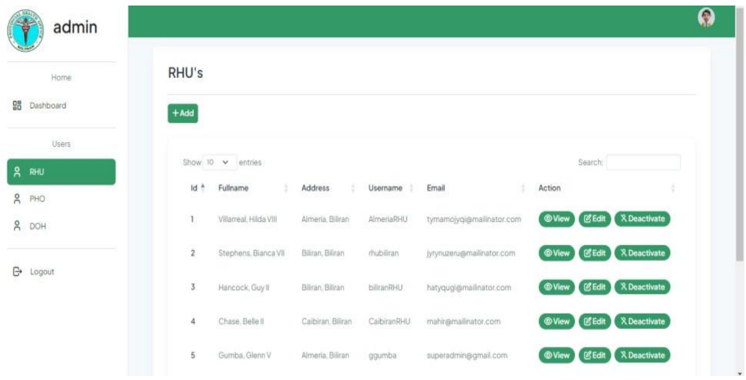
Figure 10 *Information Page for Admin*



Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

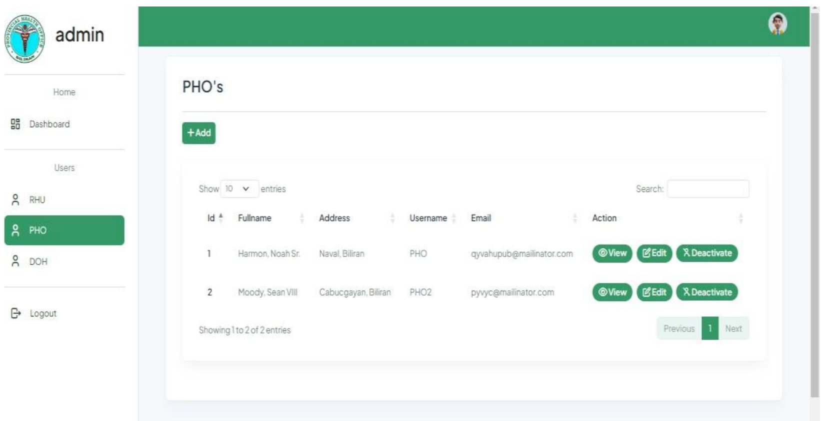
Figure 10 presents the user information management section, a crucial feature enabling administrators to view, update, and maintain user details efficiently. This section displays essential user information, including full name, suffix, birthdate, sex, province, municipality, username, and email address. The system provides intuitive controls, allowing administrators to seamlessly navigate through user records and take necessary actions. To enhance usability, the interface includes dedicated buttons for returning to the previous page, editing user details, or permanently deleting an account if needed. This functionality ensures administrators have full control over user records, enabling them to make necessary modifications while maintaining system security and data integrity. This feature offers a structured and efficient approach to user management. It supports accurate record-keeping, minimizes errors, and strengthens administrative oversight. It plays a significant role in ensuring that all user information remains current, organized, and accessible, ultimately contributing to the overall efficiency of the system.

Figure 11 *Account for RHU*



This figure shows the RHU user account management page, which serves as a tool for administrators to oversee and regulate access within the system. This feature enables administrators to create, update, or deactivate user accounts for rural health unit (RHU) personnel, ensuring that only authorized individuals can access critical health data. The system enhances security by maintaining strict control over user accounts and prevents unauthorized access to sensitive RHU information. Administrators can efficiently manage user credentials, assign appropriate permissions, and modify account settings based on staff roles and responsibilities. This form of user management strengthens data integrity, facilitates smooth operations within the RHU, and supports compliance with healthcare security standards. Through implementing a structured account management system, the RHU can optimize access control, safeguard patient information, and improve the overall efficiency of health services, ensuring that data remains accurate, secure, and accessible to the right personnel.
.

Figure 12 *Account for PHO*



Journal of Information Systems Engineering and Management
2025, 10(3)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

Figure 12 shows the user account management page designed to oversee and control Provincial Health Office (PHO) system access. This interface enables administrators to efficiently manage user accounts by allowing them to add new users, view existing accounts, make necessary modifications, and deactivate accounts when needed. The system ensures that only authorized personnel can access provincial health data by providing these functionalities, maintaining security and data integrity. Administrators can easily update user information and grant or restrict permissions based on roles and responsibilities within the PHO. This management feature is significant in safeguarding sensitive health information, preventing unauthorized modifications, and ensuring compliance with data protection policies. Through this structured account management system, the PHO can regulate user access, streamline administrative tasks, and enhance overall system security, contributing to more effective health data management and operational efficiency.

Figure 13 *Department of Health (DOH) Dashboard Page*

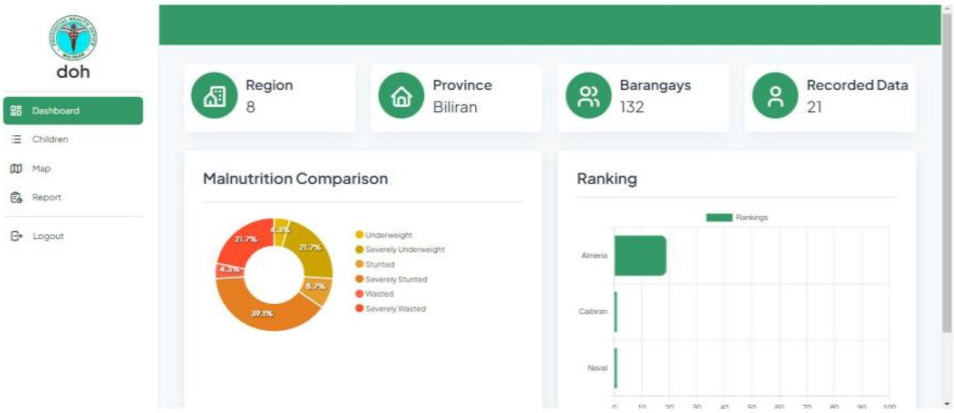


Figure 13 shows the dashboard for the Department of Health (DOH) user. It gives a simple overview of malnutrition data at the provincial level, revealing essential information about the province. The circular chart shows the percentage of children in different malnutrition categories, and a bar chart that ranks municipalities based on their malnutrition status.

Figure 14 *Report for Department of Health (DOH)*

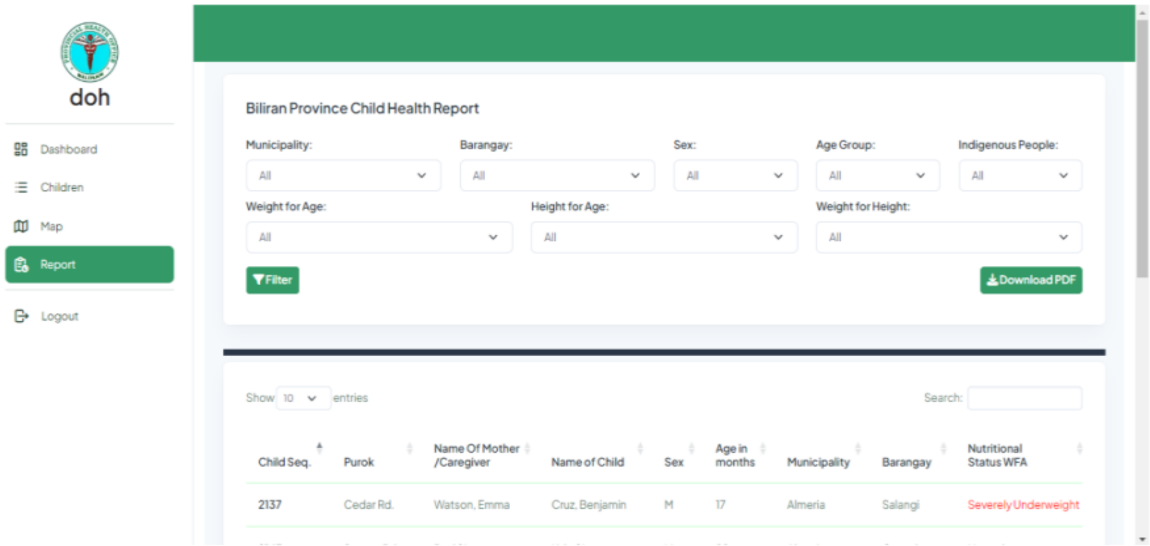


Figure 14 illustrates the system's report section, specifically developed for Department of Health (DOH) personnel. This feature enables users to generate and review provincial malnutrition reports efficiently. It provides filtering options, allowing users to refine data based on specific criteria for more targeted analysis. Additionally, the system offers the capability to download reports in pdf (Portable Document Format) formats, ensuring flexibility in data management and distribution. A detailed table is also included, presenting essential information about each child, which aids in comprehensive monitoring and assessment of malnutrition cases.

System evaluation using ISO 25010 software quality standards.

Table 4 *System Evaluation Summary*

Indicators	Mean	Interpretation
Functional Suitability	4.47	High Extent
Performance Efficiency	3.73	Moderately Extent
Compatibility	3.8	Moderately Extent
Usability	4.11	High Extent
Reliability	3.8	Moderately Extent
Security	4.04	High Extent
Maintainability	3.65	Moderately Extent
Portability	4.0	High Extent
Total Average Mean	4.0	High Extent

Table 4 shows the summary of system evaluation, indicating that the Geo-Spatial Mapping and Monitoring System of Malnutrition Trends performs well, with an overall average rating of 4.0. The results highlight key strengths and areas for improvement in the system's functionality and performance.

The system received high ratings in several aspects, including functional suitability (4.47), usability (4.11), security (4.04), and portability (4.0). These scores demonstrate that the system effectively meets its intended functions, ensuring that users can efficiently collect, classify, and visualize malnutrition data. The high usability rating indicates that the interface is user-friendly and easy to navigate, allowing health officials to access critical information without difficulty. Security was also rated highly, reflecting strong data protection measures and secure access controls, which are essential for handling sensitive health information. Additionally, the system's portability ensures that it can be deployed across different platforms with minimal configuration, increasing accessibility for various users.

However, certain aspects of the system require improvement. Performance efficiency (3.73), compatibility (3.8), reliability (3.8), and maintainability (3.65) were rated at a moderate extent, suggesting areas that could be optimized. The system's performance efficiency rating implies that while it processes and updates data effectively, further enhancements in response time and data handling capabilities could improve overall speed and accuracy. The moderate compatibility score indicates that while the system operates across different devices and platforms, further refinements are needed to ensure seamless integration with external databases and applications. Reliability was also rated at a moderate extent, meaning that occasional issues such as system downtime or synchronization errors may need to be addressed. Additionally, maintainability received the lowest rating, suggesting that improvements in system updates, debugging, and long-term maintenance could enhance sustainability. While the system effectively supports malnutrition monitoring, addressing these moderate-rated aspects can further enhance its efficiency and effectiveness.

CONCLUSION

The Malnutrition Monitoring System and Geospatial Mapping application successfully met its objectives by providing an efficient platform for tracking, analyzing, and visualizing malnutrition data. Through classification based on nutritional status, comparison charts, reports, and geospatial maps, the system effectively identified malnutrition hotspots in Biliran, enabling targeted interventions.

The integration of geospatial mapping has significantly improved monitoring by automating data collection and analysis, reducing manual errors, and enhancing accessibility for health workers. This efficiency allows for timely responses, potentially mitigating the adverse effects of delayed interventions. The system's ability to present malnutrition data visually ensures that healthcare providers can prioritize areas requiring immediate attention.

An evaluation using ISO 25010 software quality standards confirmed the system's strong performance in functionality, usability, security, and portability. However, moderate ratings in performance efficiency, compatibility, reliability, and maintainability highlight areas for future enhancement. The system serves as a valuable tool in addressing malnutrition challenges and can be further enhanced for broader applications in public health monitoring.

RECOMMENDATIONS

Based on the findings and conclusions of the study, here are several recommendations to consider:

1. Optimizing the map's performance can improve the efficiency of the geospatial mapping feature, especially in areas with slow internet connectivity.
2. The system should be adapted and implemented in other provinces or regions facing similar malnutrition challenges. It would help replicate the success of geospatial mapping and monitoring in addressing malnutrition in different areas.
3. Future studies could explore additional features, such as integrating predictive analysis tools to forecast future malnutrition trends.

REFERENCES

[1] Adebisi, Y. A., Ibrahim, K., Lucero-Prisno, D. E., Ekpenyong, A., Micheal, A. I., Chinemelum, I. G., & Sina-Odunsi, A. B. (2019). Prevalence and socio-economic impacts of malnutrition among children in Uganda. *Nutrition and Metabolic Insights*, *12*. https://doi.org/10.1177/1178638819887398

[2] Ahmad, D., Afzal, M., & Imtiaz, A. (2020). Effect of socioeconomic factors on malnutrition among children in Pakistan. *Future Business Journal*, *6*(1). https://doi.org/10.1186/s43093-020-00032-x

[3] Amadou, I., & Lawali, S. (2022). Smart Management of Malnutrition Using Local Foods: A Sustainable initiative for developing countries. *Frontiers in Sustainable Food Systems*, *6*. https://doi.org /10.3389/fsufs.2022.725536

[4] Bayu, H. G. (2019). *Applying geo-spatial information for integrating crop, food, and nutrition for a healthier food system in rural Ethiopia* (Doctoral dissertation, ADDIS ABABA UNIVERSITY). https://www.eensat.org/research/phd%20abstracts/abstract-title-habtamu.pdf

[5] Black, M. M., Lutter, C. K., & Trude, A. C. B. (2020). All children surviving and thriving: re-envisioning UNICEF's conceptual framework of malnutrition. *The Lancet Global Health*, *8*(6), e766–e767. https://doi.org/10.1016/s2214-109x(20)30122-4

[6] Dangermond, J., & Goodchild, M. F. (2019). Building geospatial infrastructure. *Geo-spatial Information Science*, *23*(1), 1–9. https://doi.org/10.1080/10095020.2019.1698274

[7] Davis, J. N., Oaks, B. M., & Engle-Stone, R. (2020). The double burden of malnutrition: a systematic review of operational definitions. *Current developments in nutrition*, 4(9).

[8] Doke, A. B., Zolekar, R. B., Patel, H., & Das, S. (2021). Geospatial mapping of groundwater potential zones using multi-criteria decision-making AHP approach in a hardrock basaltic terrain in India. *Ecological Indicators*, 127.

[9] Dukhi, N. (2020b). Global Prevalence of Malnutrition: Evidence from Literature. In *IntechOpen eBooks*. https://doi.org/10.5772/intechopen.92006

[10] *Global Nutrition Report*. (2022). About Malnutrition. Retrieved May 5, 2024, from https://globalnutritionreport.org/resources/about-malnutrition/

[11] Govender, I., Rangiah, S., Kaswa, R., & Nzaumvila, D. (2021). Malnutrition in children under the age of 5 years in a primary health care setting. *South African Family Practice*, *63*(1). https://doi.org/ 10.4102/safp.v63i1.5337

[12] Hawkes, C., Ruel, M. T., Salm, L., Sinclair, B., & Branca, F. (2020). Doubleduty actions: seizing programme and policy opportunities to address malnutrition in all its forms. *The Lancet*, 395(10218), 142-155.

[13] Juran, S., Broer, P. N., Klug, S. J., Snow, R. C., Okiro, E. A., Ouma, P. O., & Alegana, V. A. (2018). Geospatial mapping of access to timely essential surgery in sub-Saharan Africa. *BMJ global health*, e000875.

[14] Katoch, O. R. (2022). Determinants of malnutrition among children: A systematic review. *Nutrition, 96*, 111565.

[15] Khaliq, A., Wraith, D., Miller, Y., & Nambiar-Mann, S. (2021). Prevalence, Trends, and Socioeconomic Determinants of Coexisting Forms of Malnutrition Amongst Children under Five Years of Age in Pakistan. *Nutrients*, *13*(12), 4566. https://doi.org/10.3390/nu13124566

[16] Luo, H., Zyba, S. J., & Webb, P. (2020). Measuring malnutrition in all its forms: An update of the net state of nutrition index to track the global burden of malnutrition at country level. *Global Food Security*, *26*, 100453. https://doi.org/10.1016/j.gfs.2020.100453

[17] Rahutomo, R., Nurlaila, I., Perbangsa, A. S., & Pardamean, B. (2020). Database Management System Design with Time Series Modification for Child Growth and Malnutrition Monitoring in The Regency of

Serdang Bedagai. *2022 International Conference on Information Management and Technology (ICIMTech)*, 306–311. https://doi.org/10.1109/icimtech50083.2020.9211170

[18] Sadiq, A. (2013). Geospatial mapping of health facilities in Yola, Nigeria. *IOSR Journal of Environmental Science Toxicology and Food Technology*, *7*(3), 79–85. https://doi.org/10.9790/2402-0737985

[19] Saunders, J., & Smith, T. (2010). Malnutrition: causes and consequences. *Clinical Medicine*, *10*(6), 624–627. https://doi.org/10.7861/clinmedicine.10-6-624

[20] Serón-Arbeloa, C., Labarta-Monzón, L., Puzo-Foncillas, J., Mallor-Bonet, T., Lafita-López, A., Bueno-Vidales, N., & Montoro-Huguet, M. (2022). Malnutrition screening and assessment. *Nutrients*, *14*(12), 2392. https://doi.org/10.3390/nu14122392

[21] Shaughnessy, E. E., & Kirkland, L. L. (2016). Malnutrition in Hospitalized Children: A responsibility and opportunity for Pediatric hospitalists. *Hospital Pediatrics*, *6*(1), 37–41. https://doi.org/10.1542/hpeds.2015-0144

[22] Tekile, A. K., Woya, A. A., & Basha, G. W. (2019). Prevalence of malnutrition and associated factors among under-five children in Ethiopia: evidence from the 2016 Ethiopia Demographic and Health Survey. *BMC Research Notes*, *12*(1). https://doi.org/10.1186/s13104-019-4444-4

[23] UNICEF. (2019). *Levels and Trends in Child Malnutrition: Key Findings of the 2019 edition*. Retrieved May 6, 2024, from https://www.unicef.org/reports/joint-child-malnutrition-estimates-levels-and-trends-child-malnutrition-2019

[24] World Health Organization: WHO. (2024, March 1). *Malnutrition*. https://www.who.int/news-room/fact-sheets/detail/malnutrition

[25] Wu, J., Gan, W., Chao, H., & Yu, P. S. (2024). Geospatial Big Data: survey and challenges. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, *17*, 17007–17020. https://doi.org/10.1109/jstars.2024.3438376

[26] Wylie, N., Pastick, N., Picotte, N., & Deering, N. (2019). Geospatial data mining for digital raster mapping. *GIScience & Remote Sensing*, *56*(3), 406–429. https://doi.org/10.1080/15481603.2018.1517445