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Timbang App: An Operation Timbang Monitoring System

Abstract: **-** Malnutrition is one of the leading causes of diseases and infections that result in infant deaths, especially during the first five years of life. To mitigate this issue, the Rural Health Unit (RHU) of San Miguel, Bulacan, conducts Operation Timbang Plus (OPT) to identify the status of each child and locate families with malnourished children. However, the data collection is extensive and has delayed publication of results. Therefore, this project was created to help the RHU with the OPT, thus providing an IT solution that calculates, manages, and generates reports of OPT data. The project was developed using V-Model, a type of Waterfall model. Moreover, the ISO 9126 Quality Model was used to determine if the system functions were created. Lastly, unit testing, compatibility testing, stress testing, system testing, and integration testing are conducted to ensure the quality of the IT solution. The tests show that the system is compatible with Android devices and browsers such as Google Chrome, Microsoft Edge, and Mozilla Firefox. The integration test shows that mobile and web applications worked as a unified system. Lastly, the survey results show that the system's functionality and accuracy are 100% acceptable for mobile and web applications. However, the usability of web and mobile applications varies. Offering 99.5% for mobile application and 99.34% for web application. These imply that web applications can effectively organize, store, and retrieve OPT data. The mobile application can effectively collect, calculate, and report data and provide SMS notifications to parents about nutrition programs.

Keywords: Operation Timbang (OPT), Malnutrition, ISO 9126 Quality Model .

I. INTRODUCTION

The case of malnutrition in the Philippines is one of the leading causes of several diseases and infections among children. Resulting in infant deaths and deaths among children in their first five years of life. Ninety-five (95) children die of malnutrition every day, and twenty-seven out of a thousand (27/1000) Filipinos do not live until their fifth birthday (Child Survival | UNICEF Philippines, 2023). Recent reports cited that the country ranks 5th with the highest prevalence of stunted children [1]. This condition occurs in children who are undernourished but aggravated by disease and poor health conditions [2]. The Philippines National Nutrition Council (NNC) conducts Operation Timbang Plus (OPT Plus) to identify underweight, wasted, stunted, or obese children and locate families with malnourished children [3]. The barangay-level information system collects food insecurity data and monitors malnutrition prevalence among the community's most vulnerable young children. Every first quarter of the year is the busiest time for community nutrition workers and those managing nutrition programs. They spent directing the most critical aspects of implementing the local nutrition program.

One of the most critical problems in executing Operation Timbang is ensuring that the data generated is current, relevant, and accurate, given the massive weight and height data collected from over 49 barangays in San Miguel, Bulacan. Operation Timbang uses the e-OPT or the electronic Timbang MS Excel operation tool [4], which only the Municipality can access and use. In contrast, each barangay's mother leader continues to perform manual calculations of each child's nutritional status and manual report consolidation, resulting in mostly delayed results publication of nutrition data or misclassification of the nutritional status of children.

This research focuses on determining an I.T. solution that calculates Operation Timbang (OPT) data much easier, faster, and error-free. This mobile application is designed to help barangays in San Miguel, Bulacan, Philippines consolidate and communicate Operation Timbang's (OPT) results. Using this application makes the data more manageable and offers reliable data on the status of several forms of malnutrition. Complementing the benefits of consistent and regular use of the mobile app is the practice of paperless reporting, which gives nutrition workers more time for nutritional advice and actual service delivery.

Therefore, the project aims to (a) design and develop a web application to manage Operation Timbang

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information; (b) design and develop a mobile application that will be use by the mother leaders to collect, calculate, and report data from each barangay in San Miguel, Bulacan, Philippines; (c) provide SMS notification for parents to disseminate RHU programs, specifically on nutrition programs; and (d) determine the level of acceptability of the mobile and web applications' accuracy, functionality and usability.

II. METHODOLOGY

A. Method Used

To achieve the study's objectives, the researchers used the V-Model, a variation of the waterfall model, to develop mobile and web applications. A development methodology focuses on testing [5]. The researchers implemented this method to ensure that the system is of high quality and that relevant testing is implemented. The analysis comprises determining the business process, creating the use cases (e.g., use case analysis), process model (e.g., data flow diagram, context diagram), and the data model (e.g., entity-relationship model). On the other hand, the design comprises the physical system, its architecture, the interface, programs, and the databases and files. In this phase, the researchers decide how the system will operate the user interface's hardware, software, and network infrastructure, the different forms, and the reports needed from the OPT system. The implementation is the actual coding or construction of the system, wherein the various tests will commence, such as testing the software and its actual performance. Each level of testing is linked to the phase to help ensure high-quality and relevant testing and maximize the test effectiveness.

B. Analysis

The researchers gathered information and interviewed Mrs. Rhea Viola Pili, one of the Municipal Nutrition officers (MNO) [6], to determine which problem the researchers could address with an IT solution. The Bulacan province continues to implement Operation Timbang, including plan assessment and monitoring in all 21 municipalities. San Miguel is one of the largest municipalities in Bulacan, Philippines with 49 barangays, which frequently results in the delayed distribution of nutrition statistics or the inaccurate classification of children's nutritional status. Each barangay has 7 to 9 mother leaders led by the Rural Health Unit (RHU). Operation Timbang is conducted every first quarter of the year, and every barangay Mother Leader is responsible for the measurement of the weight, length, and height of every child. This process is conducted anywhere convenient to the families and the Operation Timbang team, either in a barangay hall or at their home. After the computation, the Rural Health Midwife will review and approve the results. They will present it to the Municipal Nutrition Council to develop and update the problem and identify which families will be the priority.

Based on this information, the Timbang App is developed to address the challenges the MNO and the mother leaders face. The mobile application is designed for the mother leaders, while the web application is for the municipal nutrition officers. Parents are included in the OPT users since they are the authorized representatives of their respective families and children monitored under Operation Timbang. The web application has dashboard features which showcase OPT statistics. Moreover, it also features information on family profiles, children 0-59 months, malnourished children, pregnant women, lactating women, stores, and bakeries, and they can also view and download the reports. The MNO manages the user account management and handles the access of user accounts. To ensure data security, parents can only receive SMS notifications. On the other hand, the mother leaders can only access their collected OPT data. Lastly, the MNO can manage and create reports from the collected OPT data of all mother leaders.

The Timbang App has a Calendar that features the upcoming health program or events calendar. Meanwhile, the mother leaders are the ones who manage the family profile, children 0-59 months, malnourished children, pregnant women, lactating mothers, stores, and bakeries. They can view all the generated reports needed in the Rural Health Unit. The parents will be notified via SMS whenever the nutrition officer adds a new schedule for upcoming events and programs.

C. Design

Designing the OPT System requires the architecture design to visualize how the information system components will be distributed across multiple computers and the hardware, operating systems, and application systems that will be used on each end-user utilizing a laptop or an Android phone. In the program development, the researchers based the hardware and software specifications on the minimum hardware and software available in the market.

The figure below shows how the Operation Timbang System functions. The mother leaders are conducting house visits in their assigned purok. Therefore, the mobile application is designed to ensure that the mother leaders can access the OPT. Thus, ensuring that the mother leaders can encode the collected data from each family. The researchers covered all the costs of developing the Timbang App, including a year's worth of domain and web hosting for their one (1) year trial. The package included a domain name and web hosting, a free WordPress

Toolkit, up to 50 email accounts, free SSL (Secure Socket Layers) to keep the information private and secured while using the web application, a free Malware Scan, and unmetered bandwidth. The researchers recommended upgrading the domain and web hosting because the web hosting for a year trial is limited to 10 GB storage.

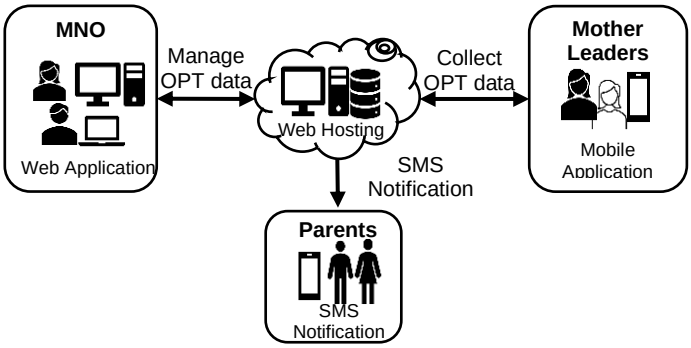

Figure 1. The Operation Timbang Monitoring System Architecture

The web application is the management side of the OplanTimbang. All data that the mother leaders will collect will be stored and displayed in real-time using the web application. The nutrition officer can see the organized data of the children's nutritional status, which has already been summarized based on their Height for Age, Weight for Age, and Weight for Height/Length.

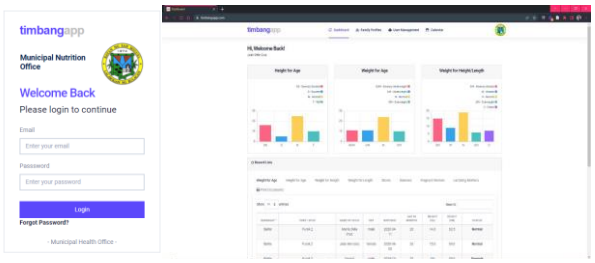

Figure 2. The design for Web Application of Operation Timbang Monitoring System

The mobile application for mother leaders comprises a menu based on the classification of responses they need for the OPT. As illustrated in the figure below, the mother leader respondent has a login form to access the application. The menu consists of a family profile, adding a child, and classification of children based on age, pregnant women, and lactating mothers. The nutrition office requested the list of bakeries and stores to be included in the system. The list contains the ingredients used in baking bread and pastries. The stores should list sari-sari stores that sell iodized salt and iron-fortified products.

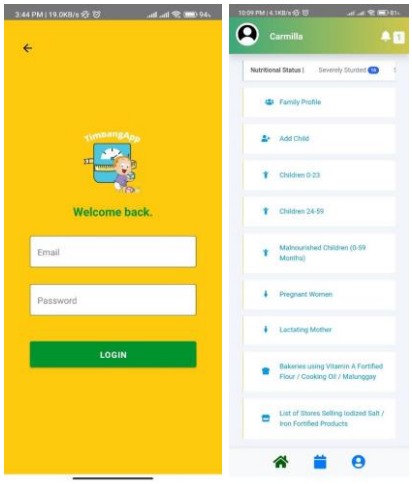

Figure 3. The design for Mobile Application of Operation Timbang Monitoring System

D. Implementation

The implementation covers the coding or programming of the backend (database) and the front end (web and mobile application) of the Timbang App. Since three (3) applications are needed for the Timbang App, the researchers divided the applications among the members. For the backend, the researchers used MySQL. The collected information is saved in the database. It is secure, easy, and free to use. PHP and MySQL are the most popular technologies for developing dynamic and academic websites and web applications. PHP, a server-side programming language, and MySQL, an open-source relational database management system, can produce unique solutions.

The Timbang App was created using the Android Studio as Frontend. Android Studio provides a rich environment with powerful tools for designing, coding, testing, and debugging Android applications [7]. It can offer various notable features that are highly creative and easy to use. For the web application, the researchers used PHP (Hypertext Pre-processor). PHP is the most often used programming language for developing websites and web applications. Using PHP has many advantages, such as support for Oracle, Sybase, and other databases. It is used to write essential functions, methods, and syntax. It also works with a database management system and an open-source database. To publish the web application online, the researchers purchased domain and web hosting services and uploaded the content to the web server.

E. Testing and Evaluation

The researchers conducted the actual testing procedure for the system to identify any errors. It is the process of looking for vulnerabilities or flaws in a system. It is a valuable instrument for ensuring that individual components function as expected. Software testing ensures that the software meets the requirements and does not fail unacceptably[5]. Tests include unit testing, integration testing, system testing and acceptance testing. The testing focused on the system requirements and have both mobile and web applications functioned adequately, compatibility using internet browsers and as well as mobile devices.

The system’s overall performance was evaluated using a survey questionnaire based on the ISO 9126 Quality Model. It offers a framework for assessing software quality [8], [9]. Moreover, the software quality model is an internationally recognized standard that supports the creation of a robust foundation for evaluating the software. ISO 9126 is often used to discuss, plan, and assess software quality. It contains measures for identifying the level at which each product's quality attributes may be reached [10].The recommended characteristics are generally defined when software is confirmed to result from internal program properties [11]. The evaluation characteristics of ISO 9126 used in this study are accuracy, functionality, and usability.

The respondents included forty-nine (49) Mother Leaders, one from each Barangays in San Miguel, Bulacan, seven (7) Nutrition Officers from the Municipal Nutrition Office of San Miguel, Bulacan, three (6) IT Experts, and three-hundred twenty-five (325) IT students for a total of three hundred eighty-seven (387) respondents. They have contributed significantly to the study by evaluating and examining the system. In addition, Total Enumeration, Stratified, and Cluster Sampling were employed as Sampling Methods. Cluster sampling is a commonly used statistical technique for analyzing large, geographically dispersed populations. Generally, researchers cluster around pre-existing groups or clusters in a population [12], [13].

On the other hand, total enumeration sampling is most practical when the entire population is manageable, such as when a well-defined portion of a larger population is involved[14]. Stratified sampling was used for the students, while the mother leader used Cluster Sampling, with one representative for each barangay. For IT Experts, the researchers used Total Enumeration.

In calculating the percentage of the evaluation, the responses were calculated by the number of respondents who answered YES divided by the total number of respondents and then multiplied by one hundred (100) using the mathematical equation shown below. A rating scale was also used to interpret the evaluation's summarized results. Moreover, the study used descriptive statistics to describe the data's characteristics and most significant aspects.

III. RESULTS AND DISCUSSION

The web application acts as the management information system of the Timbang App. This application has functions and features for managing the OPT information. The main feature of the web application is the dashboard, wherein the OPT information is organized according to the children’s status based on height for age, weight for age, and weight for height/length. Each update or new child’s information encoded via the mobile app by the mother leader is automatically stored in the system's record list, which the nutritional officer can access and monitor.

Moreover, the Timbang App can store data on pregnant women and lactating mothers and information about each sari-sari store and bakery. The print function of the web application can use the filter to print the record list. Users can filter the report based on the barangay, sitio/zone, month, and year.

Data collection is through the Timbang App Mobile App, where the mother leader collects child's information such as the barangay, family information, the child's data, and other information needed for the Oplan Timbang. Moreover, the mother leaders must also fill in the information about the parent's practices, such as if they exclusively breastfed (EBF), complementary feeding (CF), and if the child is a beneficiary of supplementary feeding (SF). Lastly, the child's nutritional status, such as their height and weight and the vitamins they took, are also collected.

A child's BMI is automatically computed after filling in the age, height, and weight. This mobile app function ensures a fast and error-free calculation of BMI to determine the child's nutritional status quickly. The mother leader does not need to bring a calculator, nor does she need to get a weighing scale to rural areas. Because the mother leaders can use the mid-upper arm circumference (MUAC) measurement to determine the nutritional status of the children by computing the age in months. Using this mobile application function, the mother leader will save time, resources, and effort in collecting all information in their assigned areas.

Announcing upcoming nutrition programs in a big municipality is quite challenging if there is no proper communication between the Municipal Nutrition Office and the Barangay Office. Distributing the information to the different families living in each barangay is essential. With the presence of the internet, especially social media platforms, nutrition officers can disseminate the programs faster to each family. However, some barangays in San Miguel are experiencing intermittent signals, which limits their access to the internet. Therefore, the SMS notification of the Timbang App web application is added to help disseminate announcements and other information to the parent's registered mobile number. This allows the faster dissemination of the announcements. Moreover, it saves time, resources, and effort to manually call or text the parents to inform them about the programs.

The researchers conducted initial unit testing to assess the compatibility of mobile and web applications with diverse devices before the nutrition officers evaluated the applications. Certain hyperlinks required updating during the test, and minor errors necessitated correction. After the unit test, the researchers also examined whether the mobile application could manage many devices simultaneously.

During the integration testing, the researchers successfully installed the mobile applications on three (3) Android smartphones, which include Samsung, Xiaomi, and Oppo. The web application underwent examination on different web browsers. The assessment demonstrated compatibility with Google Chrome, Microsoft Edge, and Mozilla Firefox. The web application ran smoothly in all three web browsers. Lastly, the data saved in the mobile application corresponded to the data received in the web application. The Bakery information in the mobile application matched the Bakery information in the web application.

The evaluation results of the Timbang App show that both the web and mobile applications are acceptable overall. However, it is also notable that the usability for both web and mobile applications was slightly different with the functionality and accuracy results. Based on the mother leaders' feedback, they responded "NO" because some had trouble reading the text, causing the user to be confused about all the text boxes, which can lead to inaccurate data. To resolve this concern, the researchers added a feature allowing the user to adjust the text size by pinching in to zoom in and out to zoom out based on their preferences. Because of this feature, even if the mother leader forgets their eyeglasses during their home visit, they can still use the Timbang App.

Table I. Interpretation of results for Web Application

Web Application		
Terms	**Percentage**	**Remarks**
Functionality	100%	System acceptable
Accuracy	100%	System acceptable
Usability	99.34%	System acceptable
Overall	**99.78%**	**System acceptable**

On the other hand, for the web application, one of the respondents stated that there are no height and weight units in some of the text boxes on the mobile and web applications. The respondent is not knowledgeable that nutrition status covers Height and weight. Some text boxes lack weight and height units, which cause confusion, and improper data entry. To resolve this issue, the researchers included BMI in the Nutritional Status and Kilogram (KG) and Centimeters (CM) in Height.

Table II. Interpretation of results for Mobile Application

Mobile Application		
Terms	**Percentage**	**Remarks**
Functionality	100%	System acceptable
Accuracy	100%	System acceptable

Usability	99.5%	System acceptable
Overall	**99.83%**	**System acceptable**

CONCLUSION

The Timbang App has successfully navigated through the different phases of its development, from conceptualization to implementation and testing. The developed web and mobile applications address the needs and requirements of the Municipal Nutrition Office, the mother leaders, and parents. The extensive analysis, iterative design, development process, and user feedback ensure that the project aligns with the requirements and Oplan Timbang process.

The Timbang App web application showcases an innovative feature that offers a new way for nutrition officers to collect and understand Oplan Timbang information to create an immediate intervention program for malnourished children. The dashboard feature displays the child's nutritional status and information through a dashboard. Moreover, the print function offers a readily formatted report for their report's submission to the concerned offices. On the other hand, the Timbang App mobile application provides a competitive advantage for mother leaders to easily collect, calculate, record, and report necessary information on children, pregnant women, and families in San Miguel, Bulacan. The Timbang App is further enriched with the SMS notification feature for the parents. This feature allows notification messages from the Nutrition Office about their scheduled activities, particularly nutrition programs for San Miguel, Bulacan children. Through this feature, communication with the parents became more accessible, as well as dissemination of information using notification messages for RHU activities, particularly nutrition programs. Thus, this feature provides the children who require special assistance and includes them in events such as feeding programs and other health-related activities.

Based on the survey result, the system's accuracy is 100%. The researchers ensured that the Nutritional Status or the child's BMI came from the same table or chart used by the mother leaders. The researchers tested and included all the tasks and processes of mother leaders and RHU in mobile and web applications. The functionality gathers 100% because all system functions are working correctly without problems, especially in computing the child's Nutritional Status. The system's overall usability accumulated 99.42%, and the system is accessible according to the respondents, with only minor changes in some of the text boxes. The remaining 0.58% who said "NO" were the mother leaders and a panel member who suggested including units in Height and Weight and BMI in Nutritional Status. The researchers solved these problems by including BMI in the height of the nutritional status, kilograms (KG), and centimeters (CM). The researchers also added a feature allowing the user to adjust the text size by pinching in to zoom in and out to zoom out based on their preferences.

Based on the findings and outcomes of the project, the following recommendations are essential to enhance the effectiveness and success of the Timbang App:

1. Add a Tagalog version of the SMS notification to reach all parents and understand the information about the programs and events in English and Tagalog dialects.

2.The Timbang App can be improved by adding elementary teachers as mobile application users, as they can also perform Oplan Timbang in their respective schools.

3. The researchers also suggested adding the First 1,000 days of Child Vaccination for a broader scope in health because it is also one of the factors that may affect the children's nutritional status. The researchers also recommend improving the system by adding features that allow the system to be flexible and open for all users.

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