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A Web-Based Application to Determine Nutritional Status in Toddlers using the Z-Score Calculation Method at the Kambaniru Health Center

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Abstract

Nutrition is very important for the growth period of toddlers to grow and develop optimally, lack of knowledge from parents in nutritional problems in toddlers makes children eat food that is not in accordance with the needs of their body systems. Nutrition is also one of the main determinants of the quality of human resources, especially in toddlers. Nutrition and content of food consumed by humans have an influence on the development of the human brain and body, especially in toddlers. The nutritional needs and nutrition of toddlers will certainly be different from the needs of adults because they are in the period of growth and development. Based on the results of an interview with one of the nutritionists at the Kambaniru Health Center, it is known that nutritionists use manual calculations by looking at the z-score value of each toddler and then determining the nutritional status of each toddler. Therefore, to help the performance of nutritionists, an application is needed that assists nutritionists in determining the nutritional status of toddlers. Nutrition that does not have the right amount of nutrition can make nutritional disorders appear. The nutritional status experienced by toddlers is divided into 4 categories, namely good nutrition, poor nutrition, poor nutrition, and overnutrition. In this study, a system was made using xampp. The design of a web-based application of nutritional status in toddlers uses the z-score calculation method at the Kambaniru Health Center to make it easier for nutritionists to determine the nutritional status of toddlers. Based on the results of the black box test, it shows that all the features of the application run with their functions. Meanwhile, from the results of the system usability scale test , it was concluded that the test results of 10 respondents obtained a base score of 84.25, the results showed that the system had an acceptability range level of "acceptable" or suitable for use, while the grade scale level or scale assessment obtained a value of "B", and the assessment of adjective ratings It is included in the extraordinary category so that the existence of this system can help the Kambaniru Health Center in determining the nutritional status of toddlers.

Keywords: *Application Design, Nutrition Status, Z-score, XAMPP*

1. Introduction

Nutrition is a substance that is very influential for the development of the human body so that the functions of the human body can run properly. Nutritional status is where nutritional intake is balanced with the needs of the human body, especially in toddlers. If a person or child experiences excess nutritional intake, it is not good for the body.
Nutritional fulfillment in toddlers is very important because nutrition is a factor that needs to be considered to maintain the health of toddlers, because toddlers are very vulnerable to nutrition. Toddlers are a group of children who experience a growth and development cycle that requires more nutrients than other age groups so that toddlers are usually very susceptible to nutritional disorders. At the age of 0 to 5 years, toddlers experience physical, mental and behavioral development, therefore toddlers need special attention in terms of their nutrition.

The method used to determine the nutritional status of the toddler is using the Z-Score method which includes BB/U (Weight/Age), PB/U (Body Length/Age), BB/TB (Weight/Height), and BMI/U (Body Mass Index/Age) based on anthropometric standards in accordance with the decision of the Ministry of Health of the Republic of Indonesia Number: 1995/MENKES/SK/XII/2010.
Currently, to find out the nutritional status of toddlers, Posyandu uses data from anthropometry. Anthropometry is a field of science related to the dimensional measurement of human body parts such as height, weight, head circumference, chest circumference and other parts of the human body. Posyandu also uses a Healthy Towards Health Card (KMS) which is filled out once a month to monitor the development of the nutritional status of toddlers. The Towards Health Card is only used as a determinant of one of the nutritional statuses experienced by toddlers, namely weight based on the age of the toddler [1], [2], [3].

2. Theoretical Foundations

2.1. Toddler

Toddler is a very common term used for children who are 5 years old. Toddlers are a group of children who are very vulnerable to health and nutrition. If toddlers experience malnutrition, it can result in a failure in the growth and development of the child's brain. When toddlers are undernourished, it will inhibit children's growth, be susceptible to infectious diseases and can also result in a low level of children's intelligence [4].

2.2. Anthropometry

Based on the Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2020 concerning Children's Anthropometric Standards, Children's Anthropometric Standards can be used in assessing and determining children's nutritional status. The assessment was applied by comparing the results of weight and height measurements based on the Children's Anthropometric Standards. The assessment classification is based on the Anthropometric Index which is in accordance with the WHO Child Growth Standards nutritional status category for children aged 0-5 years and The WHO *Reference* 2007 for children aged 5-18 years [5], [6], [7], [8].

2.3. Z-Score

The World Health Organization (WHO) uses a standard deviation or Z-Score. In activities to measure and monitor the growth and development of toddlers. The following is the formula used in calculating the nutritional status of toddlers using the *Z-Score* calculation method [9], [10], [11].

$$\text{Z-Score} = \frac{\text{NIS-NMBR}}{\text{NSBR}}$$

NIS : Individual Values of Subjects
NMBR : Reference Standard Median Value
NSBR : Standard Reference Junction Value

The assessment of the nutritional status of toddlers is carried out using child anthropometric standards, namely comparing the results of measuring weight and height and the age of toddlers, which is calculated using the z-score formula. Classification in nutritional status assessment based on anthropometric standards that have been recommended by the WHO Child Growth Standards for children aged 0-5 years. The following are indicators in the assessment of nutritional status based on the WHO-NCHS Anthropometric Standard Index at BB/U, TB/U, BB/TB.

Table 1: Z-Score Method Indicator

INDICATORS	*Z-SCORE*	NUTRITIONAL STATUS
Weight According to Age (BB/U)	< - 3SD	Malnutrition
	-3 SD to < - 2 SD	Undernutrition
	-2 SD to 2 SD	Normal Nutrition
	> 2SD	More Nutrition
Height According to Lifespan (TB/U)	< - 3 SD	Very Short
	- 3 SD to < - 2 SD	Short
	- 2 SD to 2 SD	Usual
	> 2 SD	Very High
Weight According to Height	< - 3 SD	Very Skinny
	- 3 SD to < - 2 SD	Thin
	- 2 SD to 2 SD	Usual
	> 2 SD	Fat

2.4. Examples of Z-Score Method Application

The following is an example of determining the nutritional status of toddlers using the
There was a 44-month-old boy with a height of 93 cm and a weight of 11.6 kg without knowing his nutritional status on good, bad or more nutritional status.

a. Determining Nutritional Status based on Weight/Age
   BB Individual : 11.6
   BB Median : 15.7
   BB Simpang : 13.8

   $$\text{Z-Score} = \frac{11.6-15.7}{13,8-15,7}$$
   $$\text{Z-Score} = \frac{-4.1}{-1,9}$$
   Z-Score = 2.28 SD
   Based on the calculation that the Z-Score is at > +3 SD and reaches 1.SD, it can be concluded that the nutritional status is based on BB/U Being in the overweight category
b. Determining Nutritional Status Based on Height/Age
   TB Individual : 93
   TB Median : 101.0
   Simpang TB : 97.0

Z-Score = 93 – 101.0
97,0-101,0
Z-Score = -8
-4
Z-Score = 2
Based on the calculation that *the* Z-Score is at -2 SD to +3 SD and reaches 2 SD, it can be concluded that the nutritional status based on TB/U is in the normal category

c. Determining Nutritional Status based on Weight/Height
BB Individual : 11.6
BB/TB Median : 13.6
BB/TB Simpang : 12.6
Z-Score = 11.6-13.6
12,6-13,6
Z-Score = -2
-1
Z-Score = 2 SD
Based on the calculation that the Z-Score is at > + 1 SD + 2 SD and reaches 2 SD, it can be concluded that the nutritional status is based on BB/TB is in the category of Risk of over nutrition

2.5. Waterfall Method

This child's nutritional status system uses a waterfall approach. The waterfall method is a development method that is carried out by providing a sequential approach and there are several phases of the life flow of software that involve the waterfall method, namely the analysis, design, coding, testing, and maintenance phases.

2.6. System Usability Scale (SUS)

System usability scale (SUS) is a questionnaire used to measure system usability; SUS is a calculation in numbers that tests the usability of a system performance so that it can work according to what the user wants so that the system can run well.

3. Research Methodology

3.1. Research Flow

The several stages of research carried out are as follows:

Figure 1: Research flow

In this research flow, there are several stages of research carried out

1. Data Collection
   In this study, to obtain accurate data in determining the problems that exist in the Kambaniru Health Center, 3 methods of data collection are carried out, namely:
   a. Interview: The interview stage is conducted directly at the Kambaniru Health Center. The results of the interview can be used as a reference in processing data on the nutritional status of toddlers. The interview was conducted directly with a nutritionist at the Kambaniru Health Center.
   b. Observation: At the observation stage, it was carried out directly how to collect toddler data taken from posyandu activities.
   c. Documentation: Data collected directly from source documents at the Kambaniru health center.
2. System Creation
   At this stage, the aim is to create a system flow so that each research is well structured, starting from the design of the Unified Modeling Language (UML) which includes several diagrams such as Use Case Diagrams, Activity Diagrams, Sequence Diagrams and Class Diagrams to User Interface Design.
3. Implementation
   At the implementation stage, the user system uses the PHP (Programming Hypertext PreProcessor) programming language and data storage uses MySql as the database management system. System Testing
4. Verification
   Verification is carried out through Black box testing which is a process to test the system that has been created. After the coding is completed, testing is carried out on the system that has been made previously. The goal is to find bugs in the system so that they can fix them later
5. System Testing
   The System Usability Scale (SUS) test is a test that is carried out on users. This test is carried out on one nutritionist and nine Posyandu cadres at the health center to determine user satisfaction with the system built. At this stage, the researcher provides a questionnaire to assess the system that has been built.

3.2. Use Case Diagram

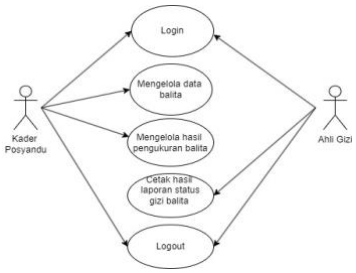

Figure 2: Use Case Diagram

In figure 2, there are 2 actors in the system that were built, namely: Posyandu Cadres and Nutritionists. Posyandu cadres can carry out the login process first, then manage toddler data, process toddler measurement data, print toddler nutritional status reports and logout. Meanwhile, Nutritionists can log *in*, print nutrition status reports and *log out*.

3.3. Activity Diagram

1. View Toddler Data
   In the Activity Diagram, figure 3 shows the activity of the toddler data viewing chart, here the cadre opens the toddler data page, then the system will display all existing toddler data.

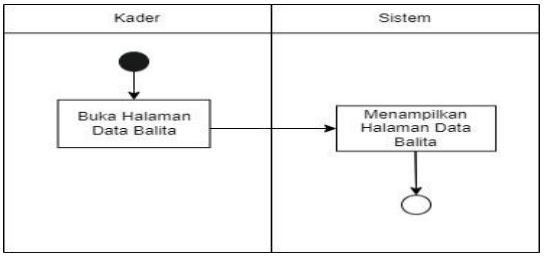

Figure 3: View Toddler Data Activity Diagram

2. Add Toddler Data
   In figure 4. Activity Diagram to add toddler data, where when opening the toddler data add page, it will appear in the toddler data add page system and then posyandu officers will fill in toddler data such as toddler NIK, toddler name, gender, date of birth, weight, height and others. After that, click the verification button, if the data entered does not match, the system will automatically return to the page to add toddler data and if the data entered is correct, the data will be saved. After that, the system will display the toddler data page.

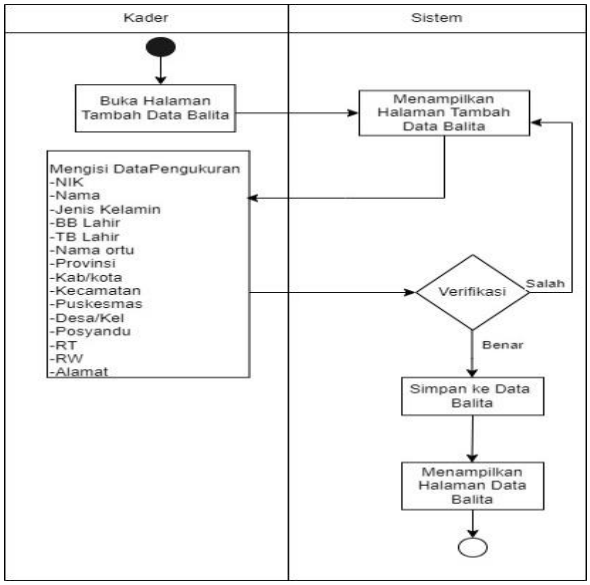

Figure 4: Add Toddler Data Activity Diagram

3. Edit Toddler Data
   In figure 5. is an Activity Diagram to edit toddler data, where the cadre opens the toddler data edit page, after which the system displays the toddler data edit page, after that click the edit menu, the system displays the toddler data edit form, then the cadre fills in the toddler data that you want to edit and save the toddler data after that click the verification button if the data entered is incorrect, it will automatically return to the form display Edit the toddler data and if the data is filled in correctly it will continue to the next page, which is to save the changes to the toddler data and the last one the system will display the toddler data that has been changed.

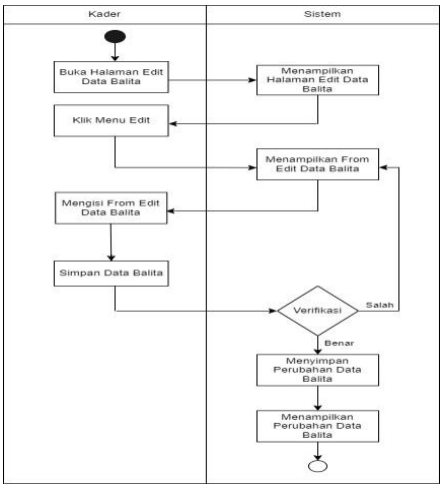

Figure 5: Edit Toddler Data Activity Diagram

4. Delete Toddler Data
   In figure 5 is a Diagram of the Activity of deleting toddler data, where the cadre opens the toddler data page after that the system displays the toddler data, after that click the delete menu, the system will display the form to delete toddler data then click the OK button then the system will delete the toddler data and database that you want to delete.

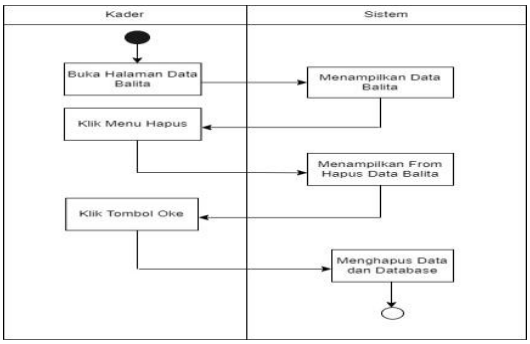

Figure 6: Delete Toddler Data Activity Diagram

4. Results and Discussion

4.1. Interface Implementation

Implementation is an explanation of the creation of the system and application display that has been built, as well as explaining the usability and function of each application page. The implementation of the design of a web-based nutrition status determinant application with SDLC modeling is in accordance with the system design that has been described previously in the form of the display of each system page. In explaining the form of implementation, here is an explanation and function of each page view created.

1. Login Page
   The Login page is the first page when opening the system. On the login page, there is a username and password input form from the user. Here cadres and nutritionists can input usernames and passwords. Then the system will validate the username and password that has been inputted. If it is true, the system will display the dashboard page. If it is wrong, the cadre and nutritionist will be redirected to re-enter the username and password.

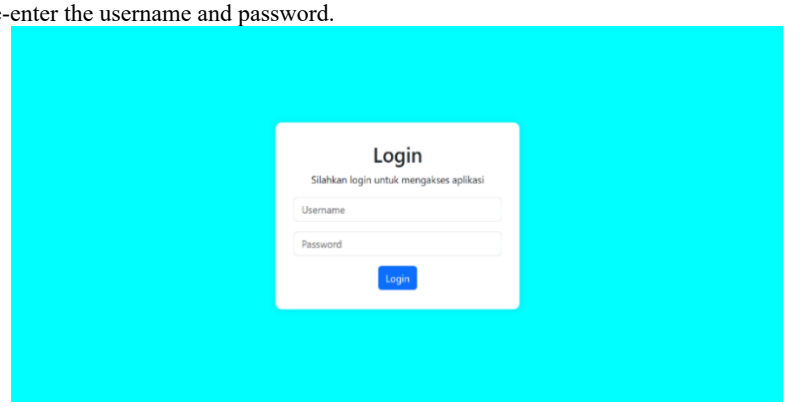

Figure 7: Login Page

2. Dashboard Page

On this page you will find the name of the system and the logout button in the header. On the Dashboard page, there is a toddler growth and development graph and there are 7 menus on the sidebar, including user menu, anthropometry, toddler data, weight, height, monthly data and nutritional status. Cadres can access each menu when they want to manage the data contained in each menu.

Figure 8: Dashboard Page

3. Toddler Data View Page

On the page view toddler data contains a table containing toddler data numbers, toddler NIK, and toddler names then on the left side there is a detail menu, edit, delete and measure.

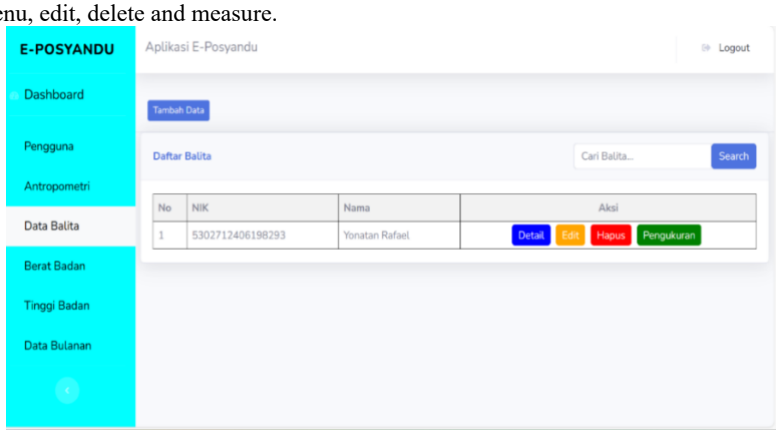

Figure 9: Toddler Data View Page

4. Toddler Data Detail Page

On the toddler data detail page to see the toddler data in full, click the detail menu, then the toddler data will be displayed in detail.

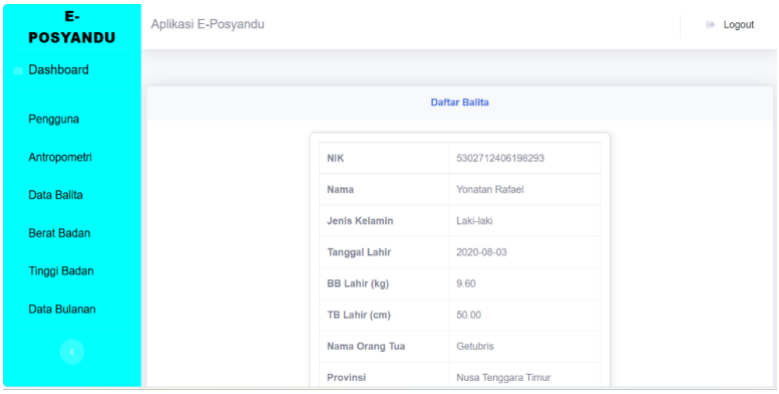

Figure 10: Toddler Data Detail Page

5. Toddler Data Addition Page

On the page to add toddler data, cadres can manage toddler data by entering NIK, name, gender, date of birth, BB born, TB born, parent's name, province, regency/city, sub-district, health center, village/sub-district, Posyandu, RT, RW and address.

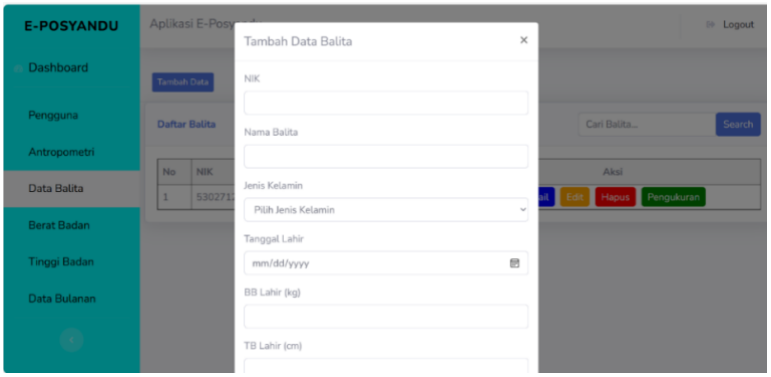

Figure 11: Toddler Data Addition Page

6. Toddler Data Edit Page
   On the toddler data edit page, cadres can manage toddler data by editing the NIK, name, gender, date of birth, BB born, TB born, parent's name, province, regency/city, sub-district, Puskesmas, village/sub-district, Posyandu, RT, RW and address according to what you want to edit.

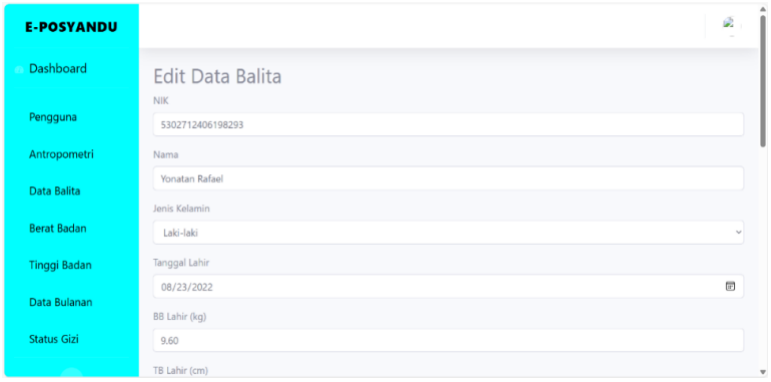

Figure 12: Toddler Data Edit Page

7. Toddler Data Delete Page
   Page deletes toddler data. On the left side of toddler data there is a delete menu, if you want to delete toddler data, click the delete menu, then a notification will appear if you want to delete, then click Ok.

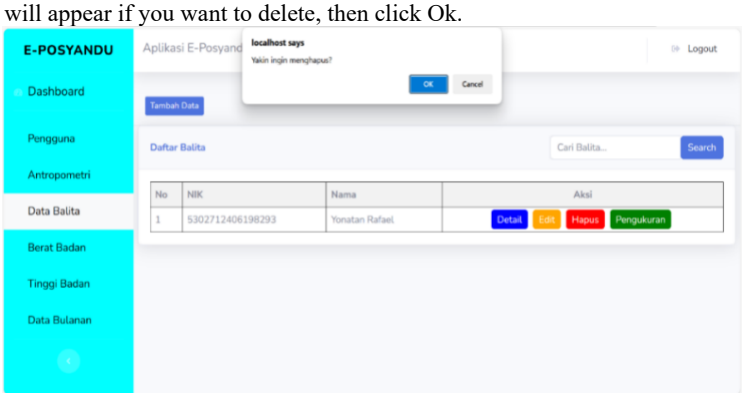

Figure 13: Toddler Data Delete Page

8. View Measurement Data Page
   On the view measurement data page. On the toddler data page there is a measurement menu, if you want to see the measurement data, then click the measurement menu and it will be directed to this page. On the measurement data page, there are Weight, Height, and LILA measurement dates.

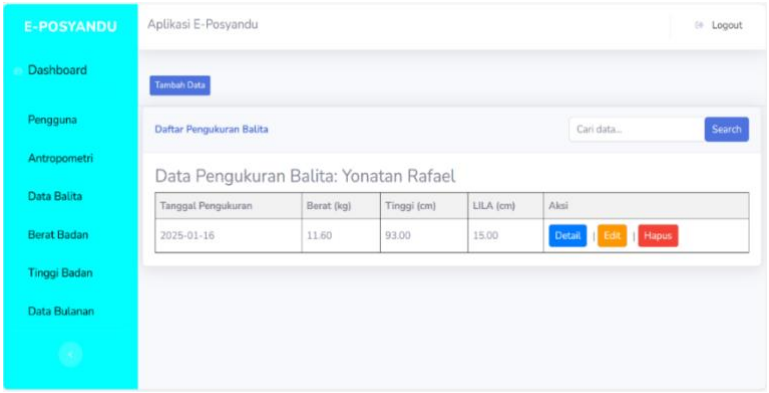

Figure 14: View Measurement Data Page

9. Measurement Data Detail Page
   On the measurement data detail page to see all the measurement data from the toddler, click the detail menu on the left of the measurement data, then the detailed toddler measurement data will be displayed.

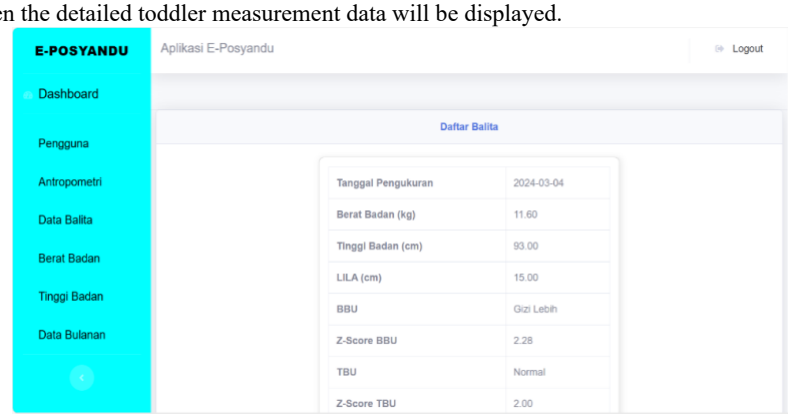

Figure 15: Measurement Data Detail Page

4.2. Black Box *Testing*

The first stage of testing is testing using black box testing. The following test results that have been carried out can be seen below:

Table 2: Black Box Testing

Function Name	Form of Testing	Expected Results	Test Results
Login	a. Invalid username and password b. Valid username and password	a. Displays a message that the username and password do not match b. The system accepts login access and displays the home page	Succeed
Logout	Select the Logout menu	The system will decide on access rights user and will display the login page again.	Succeed
View toddler data	Select the view toddler data button	The system will display all the toddler's data	Succeed
Add toddler data	Select the add toddler data button	The system adds a new row or column to add the input toddler data.	Succeed
Edit toddler data	Select the toddler data edit button	The selected toddler data was successfully edited	Succeed
Delete toddler data	Pressing the delete button to delete toddler data	The toddler data you want to delete is successfully deleted	Succeed
View toddler measurement data	Select the button to view toddler measurement data	The system will display the toddler measurement data	Succeed
Print toddler data report	Enter the month, year you want to display	The toddler's data will be displayed, then press the print button to download the report	Succeed

Based on the test results that have been tested using the Black Box, it shows that all the functions made are 100% successful in running as expected.

4.3. System Usabilty Scale (SUS) Testing

The second stage of testing uses the System usability scale method which is a test carried out directly by the end user. The following are the test results of the System Usability scale obtained from 10 respondents in charge of managing toddler data:

Table 3: Score Results from Respondents

Respondents	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
R1	5	5	5	2	5	3	5	1	5	5
R2	5	5	4	3	5	2	4	2	5	5
R3	5	5	5	2	5	2	4	2	5	4
R4	5	5	4	2	4	2	5	1	3	5
R5	5	5	5	2	5	1	5	1	5	5
R6	5	5	5	2	4	1	5	2	4	5
R7	5	5	5	1	4	1	5	1	4	3
R8	5	5	4	1	5	2	4	1	5	4
R9	5	5	5	2	5	1	5	2	5	3
R10	5	5	5	1	5	2	5	1	4	5

Table 4: SUS Score Analysis

Respondents	SUS Statement										Total	SUS Score
	1	2	3	4	5	6	7	8	9	10		
R1	4	4	4	3	4	2	4	4	4	4	37	92.5
R2	4	4	1	2	4	3	1	3	4	4	30	75
R3	4	4	4	3	4	3	1	3	4	1	31	77.5
R4	4	4	1	3	1	3	4	4	2	4	31	77.5
R5	4	4	4	3	4	4	4	4	4	4	39	97.5

R6	4	4	4	4	1	4	4	3	1	4	33	82.5
R7	4	4	4	4	1	4	4	4	1	4	34	85
R8	4	4	1	4	4	3	1	4	4	1	30	75
R9	4	4	4	3	4	4	4	3	4	2	36	90
R10	4	4	4	4	4	3	4	4	1	4	36	90
Average Score												**84,25**

From the results of the calculation of the average score of SUS, it shows a score of 84.25. Based on the average value obtained, the nutritional status determination system has a high level of ease of use according to respondents.

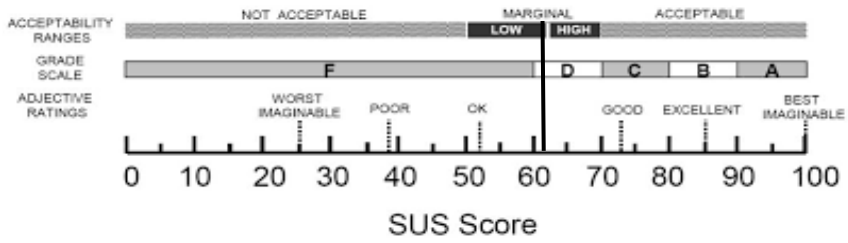

Figure 16: SUS Score

From the determination of acceptability, grade scale, adjective ratings, acceptability is included in the acceptable category, grade scale is included in the B value, adjective ratings are included in the excellent value.

5. Conclusion

Based on the results of the black box test , it was found that all functions or features can be used properly so that they can be used to record the needs of toddler data and measure z-score values, while in the SUS test, there were 10 respondents at the Kambaniru Health Center who got a score of 84.25 with an acceptability level of "acceptable" or suitable for use, while the grade scale level or a scale assessment gets a "B" grade, and an adjective ratings assessment or user experience gets an "excellent" user experience. From the two tests that have been carried out, it can be concluded that the system is very good and can be used by users.

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