

The Using Of Information Systems To Calculate Z-Score And To Determination Of Stunting Categories In Toddlers

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Abstract

Information technology is an inseparable part of human work today. It is growing very rapidly along with the human need for the speed at which information is processed until it is displayed to the user. Information systems are now widely used in all sectors, ranging from: economy, agriculture, health and so on. In the health sector, many health facilities have used information systems to improve services, one of which is Posyandu. Posyandu is the front line in providing family health services at the village level. Currently, Posyandu focus is preventing malnutrition or stunting. Standardization of stunt calculation data often changes. In addition, the calculation and documentation of toddler examination data is also still done manually. This has an impact on the efficiency of the performance of staff in determining toddlers who are affected by stunting. Data integration with the Ministry of Health is also a problem when recorded manually. Therefore, it is proposed that an information system that functions to perform Z-Score calculations and classify them into stunting or non-stunting groups. The existence of this information system can also support the government to encourage data integration between local governments and the center regarding stunting data. It is hoped that this information system can help the work efficiency of health cadres to record toddlers who fall into the Stunting category. In addition, it is also possible for the government to access data stored in the system to support data integration.

I. INTRODUCTION

Stunting is something that can be used as an indicator to describe the level of prosperity in a family. This is because the condition of stunting only occurs in young people who suffer from malnutrition. Short-term effects of Stunting can interfere with the development of the brain [1]. Food and exclusive milk as well as the presence of infectious diseases to young people are the cause of the occurrence Stunting [2]. Balita suffering from Stunting will be detected from the measurement of weight, length and circumference of the head. Such measurements are routine and generally done once a month in Posyandu.

Posyandu has a primary function as a driver for the application of healthy lifestyle for mothers and children [3]. One indicator of the success of the program is by the reduction or even not found Stunting cases. It has been explained earlier that Stunting can be detected after weighing weight, length and circumference of the head. The results of the measurement will be recalculated using the Z-Score formula. The Z-score formula will calculate weight by age, height by age and length by weight [4].

Problems begin to arise when the process of calculating Z-Scores using anthropometric data is carried out. These data are standard reference data issued by the WHO and have been validated by the Ministry of Health of the Republic of Indonesia. The Anthropometrics data are also used in the calculation of the z-scoring formula.

The implementation of an information system to help calculate the stunts will help to streamline the time of the stunting calculation for the health care personnel in Posyandu. Data accuracy is also an inescapable advantage. The use of information systems in the calculation process will make calculations until the classification of the status of the results of the calculations becomes automatic. Through the application of this information system,

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the data can also be integrated with the health information system owned by the Government, so that the data is accessible quickly.

II. METHODS

The prototyping method is used because it allows users and programmers to interact continuously during the development of the system [5]. So, if there are shortcomings during the construction, programmers will immediately repair the system. Here are the stages undertaken in this study.

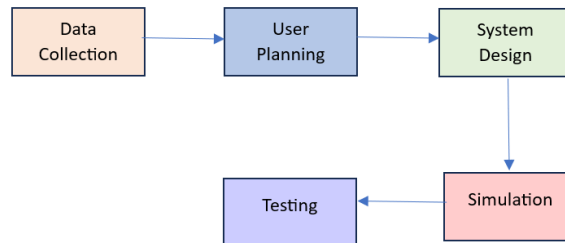


Fig. 1 Research phase

A. Data Collection

Data collection is a research process carried out by means of interviews or by collecting literature through books, papers or other sources aimed at obtaining accurate information [6]. The process focuses on finding the formula and how to calculate the data of the measurement results on the news. This formula can categorize whether a particular news belongs to the category of stunting or not.

Stunting is a condition in which the height or length of the body does not correspond to the age of the child [7]. The stunting condition can be determined by comparing the body height of the boy with the standard deviation (- 2 SD) of the WHO. If the heights of the girl are below the deviation standard, then the girl belongs to the Stunting. In addition to height, there are four important things in the calculation of Stunting on young, namely: gender and weight [8].

According to the guidelines of the Ministry of Health 2020 there are several categories of nutritional status for young people if the indicators used are age, length and weight [9]. Table 1 shows the nutritional category of young people.

TABLE 1
 TODDLER NUTRITION CATEGORY

Index	Category
Weight by age 0 to 60 months	Weight is very low (severely underweight) Less weight (underweight) Normal weight Risk of overweight
Age 0 – 60 months	Very short (severely stunted) Short (stunted) Normal High
Weight depending on length/height age 0 – 60 months	Poor nutrition (severely wasted) Poor nutrient (wasted) Good nutrients (normal) Risk of higher nutrition More nutrients Obesity

B. Calculation Formula

Generally speaking, the formula for calculating stunting news is to look for a Z-Score value. This value will then be compared from each category, whether the Z-score value meets the threshold value of certain categories. The formula (1) is for determining Z -Score.

$$\frac{N1 - NM}{\text{Nilai Simpang Baku Rujukan}} \quad (1)$$

N1 being the Individual Value (length/height and weight) while NM is the median value [10]. Table 2 shows the Z-Score threshold value of each category.

TABLE 2
 Z-SCORE THRESHOLD VALUE

Category Nutrition Status	Threshold Value Z-Score
Weight is very low (Severely underweight)	<-3 SD
Less weight	-3 SD to <-2 SD
Normal weight	- 2 SD to +1 SD
Risk of overweight	> +1 SD
Very short (Severely stunted)	<-3 SD
Short (Stunted)	-3 SD to <-2 SD
Normal	-2 SD to +3 SD
Height	> +3 SD
Poor nutrition (Severely wasted)	< -3 SD
Poor nutrition (wasted)	- 3 SD to <- 2 SD
Good nutrition (Normal)	-2 SD to +1 SD
Risking more nutrition (Possible risk of overweight)	> +1 SD to +2 SD
Overweight	> + 2 SD to + 3 SD
Obesity (Obese)	> + 3 SD

C. User Planning

Before the system is built, we need to do an analysis of whoever uses the system. The implementation of this system will be used in Posyandu and the village as the data center of each of the posyandu. Posyandu is a public health service administered by a community in a particular village. Posyandu's foundation is aimed not only to provide health to the village people, but also to provide advice to raise public awareness of the importance of health. The members of Posyandu are members of the PKK, community figures in the village as well as health cadres and communities appointed to assist activities in Posyandu. The public cadres who have been appointed will be given basic knowledge about health which will be used to provide advice by means of visits to each home individually or in groups [13].

Based on the division of groups in this Posyandu, it can be concluded that there are at least 3 users of this application, namely: the primary administrator of the application at the village level (Admin), the health cadre (Bidan) and health cadres that come from the community. As to the details as well as the roles of each user of this system are described in table 3.

TABLE 3
 SYSTEM USAGE PLAN

User	Role
Administrator	The primary system operator who can monitor the data that enters each Posyandu.
Midwife	The operator who monitors the measurement data of news entering the system in a particular Posyandu.
Health cadres	The operator that can enter the measurement data of each news on a particular Posyandu.

D. System Design

This process is the process of designing the system to be created. This phase is done by performing a breakdown process on the problem encountered using the Use Case, Activity Diagram to the system mockup to be created [14]. System design also covers what programming languages will be used as well as the design of the system's interface display. The system will be able to accommodate input in the form of news measurement data. After that, the system can perform calculations and display results in the category of news that is stunted. At this stage, the process of functional and non-functional needs analysis is also carried out [15].

Functional analysis covers user design and simulation of system usage, while non-functional analytics covers design of minimum system requirements such as hardware and software.

Codeigniter separates the syntax that contains data manipulation in the database (Model), the output view and the model connector with the View (Controller) [16]. The MVC method available in CodeIgniter provides an advantage in terms of performance that can be done easily and quickly [17]. This is because Codeigniter has its own architecture and library that can make it easier for users to build information systems.

E. Simulation

The simulation was carried out using one mistake of news measurement data that exists in each Posyandu. The baby's name uses the Baby A initials to keep Balita's personal data confidential.

This simulation process will be a benchmark for system improvement. Bidan and the health cadres are also involved in obtaining inputs from the information system created. This process will be completed when the information system is ready for use.

F. Testing

The test phase is the phase that is performed after the system is completed. This test phase is done using all the features available on the system. The process aims to find out if there were any errors during the manufacture while testing all the features on the system can run as planned. According to the use of prototyping methods, if there are errors or additional features from the user during the test period, then the system will remain developed. Therefore, at this stage of testing the important thing that is needed is communication and the use of case simulation to ensure the system has been compliant [18].

III. RESULTS

The information system will be built using MySQL DBMS (Database Management System). This type of DBMS is very commonly used, besides query processing is faster than other DBMS. It's because the query writing is simpler and not too strict.

A. Database

There are several tables used in making this system, such tables are: news, tables that store the default data formula median values of each calculation, check, officer, posyandu, village, user. Table 4 shows basic news data.

TABLE 4
 BASIC DATA FOR TODDLER

Column	Information
idbalita	Primary Key dari balita.
idposyandu	Foreign Key dari tabel Posyandu.
iddesa	Foreign Key dari tabel Desa.
nama_balita	Nama balita.
tgl_lahir	Tanggal lahir balita.
jk	Jenis kelamin balita.
nama_ayah	Nama ayah balita.
nama_ibu	Nama ibu balita.
alamat	Alamat orangtua balita

In addition to the tables for storing the new base data, there are also tables to store the formula data of each calculation that will be later compared with the system's calculation results. This table is divided into several tables. The division is based on the gender of the young, or calculation. Calculation in the category of stunting or not is done by counting body height by age (TB/U), weight by age(BB/U) and weight by height (BB/TB).

TABLE 5
 STANDARD FORMULA

Column	Information
idrumusbaku	Primary Key of the formula_table.
pembagi	The column to store the divider data of each calculation (Old/High)
median	Average value used to compare the length/height of the news.
min_1sd	The -1 SD value to be used when the height/weight of the news is less than the median value.
plus_1sd	The +1 SD value to be used when the height/weight of the news is higher than the median value.

Table 6 shows a check table. This table is used to store news measurement data. The news data measurements used for calculating Stunts are high and heavy. The age unit uses the month instead of the year. Age counting starts from 0 months to 60 months.

TABLE 6
 CHECK DATA

Column	Information
idperiksa	Primary Key of the Check table.
idbalita	Foreign Key of the Balita table.
idposyandu	Foreign Key of the Posyandu table.
idpetugas	Foreign key from the Officer table.
iddesa	Foreign key from the village table.
tgl_periksa	News check date
umur	Young age when checked
berat	Weight of news when checked
tinggi	Height of news when checked
skor_1	BB/U calculation result
kategori_1	Category of BB/U calculation
skor_2	TB/U calculation results
kategori_2	Category of TB/U calculation
skor_3	BB/TB calculation results
kategori_3	Category of BB/TB calculation

Table 7 describes the User table data. This is the table that stores the user data when logging into the system. The encryption for the password used in this table is SHA1. The system can perform identification against the logged in user. This identification is done by reading the data in the status_user column for each logged-in user.

TABLE 7
 SYSTEM USAGE

User	Role
iduser	Primary Key of the User table
user_name	Username used to log in to the system
pass_word	Password name
status_user	User status (admin, midwife, healthcare)

B. Use Case Diagram

Use Case Diagram is a form of representation of the interaction between the user and the system [19]. Users of this system are grouped into three: administrator/admin, health cadres and midwives. Those three users have different tasks. The admin user level is the highest level. The next order is the virgin and the lowest level in the system is the health frame. Figure 2 is the Use Case Diagram on the system.

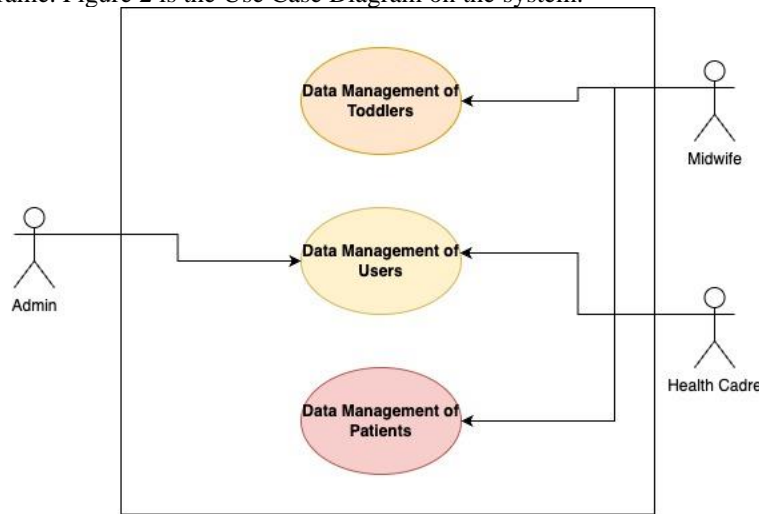


Fig. 2 Use Case Diagram

There are three management activities that can be performed by the user on the system. Data management means that the user can insert, update and delete the data.

C. System Testing Simulation

Determination of category with Stunting condition using measurements of height, age and weight. The measurement was conducted by the Health Cadre under the supervision of Bidan. As the test material of the system, it is simulated that Baby A has performed measurements of height and weight. Table 8 contains measurement data on Baby A.

TABLE 8
 MEASUREMENT DATA

Date	Age (Month)	BB (Kg)	PB (Cm)
05/01/2022	8	6,2	62
05/06/2022	13	7,2	66
05/07/2022	14	7,2	66

The measurement data will be stored in the database shown in table 5. The system will automatically enter any outcome of the criteria already entered into the database. The outcome is the Z-Score calculation and the criterion is based on the value of that Z-Score. Figure 3 shows the verification data and Figure 4 shows the result of Z-score calculations as of January 5, 2022.

No.	Tgl Periksa	Usia (Bulan)	Berat Badan (Kg)	Pjg/Tgl Badan (Cm)	Lgkr Kepala (Cm)	Ubah	Hapus
1.	05 January 2022	8	6.2	62	12	Edit	Hapus
2.	05 June 2022	15	7.2	66	12	Edit	Hapus
3.	05 July 2022	15	7.2	66	13	Edit	Hapus

Fig. 3 System Scanning Data View

Pengukuran	Nilai	Kategori BB/U	Kategori PB/U	Kategori PB/BB
Berat Badan	6.2 Cm	Gizi Baik	-	-
Panjang Badan	62 Kg	-	Pendek	-
Pjg Badan/Brt Badan	6.2 Cm/62 Kg	-	-	Normal
Lingkar Kepala			12 Cm	
Skor Perhitungan		-1.8888888888889	-2.9130434782609	-0.33333333333333
Tanggal Pengukuran		05 January 2022		
Umur		8		

Fig. 4 View Z-Score Calculation Results

D. Stunting Calculation Algorithm

The calculation algorithm used here uses arithmetic and comparative algorithms. Algorithm notation can be written in the form of Flowchart notation or narrated in Pseudocode [20]. Figure 5 shows the Flowchart about the Stunting calculation algorithm.



Fig. 5 Stunting calculation algorithm

Table 8 shows measurement data calculated from January 5, 2022 to December 5, 2022. Based on table 7, there was an increase in weight (BB) and length (PB) from January 5th, 2022 to June 5, 2022, but for June 5, 2022 until December 5, 2022 there was no increase in body weight or length.

a. Weight criteria by age

As of January 5, 2022, baby A is eight months old with a weight of 6.2 kg and a of 62 cm. Before the calculation, the system will perform gender identification. Furthermore, the baby's weight will be compared to the median value on the reference standard weight by age for babies aged 0 to 60 months. The weight standard by age from 0 to 3 months can be seen in Table 9. If you refer to the weight at Tanggal 5 January 2022, then the baby A weight exceeds the Median value. The category is normal based on the calculating his Z-Score (2).

$$\frac{bb - median}{+1SD - median} = \frac{6,2 - 3,3}{3,9 - 3,3} = -1,888889 \quad (2)$$

TABLE 9

Age (Month)	STANDARD WEIGHT BY AGE		
	-1 SD	Median	+1SD
0	2,9	3,3	3,9
1	3,9	4,5	5,1
2	4,9	5,6	6,3
3	5,7	6,4	7,2

b. Body length criteria by age

Baby A at the age of 8 months has a length/height of 62 Cm. The term body length is used for young children from 0 to 24 months, while the term body height is used to describe young people from 24 to 60 months. The calculation for determining the weight criteria by age is the same as the calculation to determine the criteria of weight by age. However, there are differences between the Median values and the standard deviation in table 8 to determine age-based height criteria. Table 10 shows the data of the standard length according to age.

TABLE 10

STANDARD BODY LENGTH BY AGE			
Age (Month)	-1 SD	Median	+1SD
0	48,0	49,9	51,8
1	52,8	54,7	56,7
2	56,4	58,4	60,4
3	59,4	61,4	63,5

Determination of body length criteria by age using the Z-Score formula as follows: $(pb - median) / (+1SD - median)$.

$$\frac{pb - median}{+1SD - median} = \frac{62 - 49,9}{56,7 - 49,9} = -2.9130434782609 \quad (3)$$

Based on the calculation of the Z-Score, Baby A enters the short criterion.

c. Body length criteria by weight

According to the standard body length guidelines, Z-Score calculations are classified according to gender and length. Once the measurement data is stored, the length data will then be matched by the system with the body longitude data that has been stored in the database. The calculation of the Z-Score (4) to determine the body length criteria by weight.

$$\frac{bb - median}{+1SD - median} = \frac{6,2 - 6,5}{7,1 - 6,5} = -0.33333333333333 \quad (4)$$

TABLE 11
STANDARD BODY LENGTH BY WEIGHT

Body Length (Cm)	-1 SD	Median	+1SD
61,5	5,9	6,4	7,0
62,0	6,0	6,5	7,1
62,5	6,1	6,7	7,2

IV. DISCUSSION

Based on the case studies listed in table 8, baby A weighs 6.2 kg and is 62 cm in length at the age of 8 months. Repeated measurements were conducted on June 5, 2022 and July 5, 2022. On both dates there was no increase in weight and length, but there was an increase compared to measurement at the age of eight months.

The weight and length data will then be calculated using the Z-Score formula. The Z-Score formula involves the Median data of each calculation. The Median Data varies depending on the criteria used.

A. Comparison Between Manual Calculations Using Information Systems

This information system is created using the MVC method. This method separates the roles between queries for data transactions on the database, the information display for the user and the link between the output and the database.

This calculation process begins when the verification data storage process is completed. Once the user has pressed the save button, the system will perform a gender categorization from Balita, this process applies to all the criteria. Once the system knows the gender of the newbie, the next step will start matching the age data and the type of criteria to be searched, assuming the searched criteria are length by age, then the matching data is age and gender.

The calculation of the Z-Score is done after the matching of the data. If you use a simulation of body length criteria by age, then your weight will be compared to the median. The median figure is in the Kemenkes 2011 Standard Anthropometry Guide. If the weight of the child exceeds the median number (5).

$$\frac{1SD - median}{BB - median} \quad (5)$$

but if instead the Median value is greater than the weight, the Z-Score formula will be changed (6).

$$\frac{median - (-1SD)}{BB - median} \quad (6)$$

If you compare time efficiency calculations with manual calculations using information systems, then you can be assured that computations using the information systems are faster and more accurate than using manual computations. This is because the calculation of the Z-Score is very likely to be a mistake. It appears that before

and after the calculations of Z-score, there are several matches of data based on gender and criteria with the standard of anthropometry to be searched for.

V. CONCLUSIONS

Information systems can be used to help in calculating the processing of Stunting data on news. Using this information system can minimize errors in the Z-Score calculation process and classification of news belonging to Stunting. In addition, the use of information systems also helps the integration process of Stunt news data in Indonesia because access to the information system use can be made Public, so that the data can be accessed via the Internet.

This information system uses a series of algorithms to be able to classify news belonging to Stunting or not Stunting. The algorithm starts by matching the gender, age and height of the young. Matching such data will include data already stored in the system database source in the Guidelines for the Standard Anthropometry of Child Nutrition Status Assessment published by the Ministry of Health of the Republic of Indonesia in 2010.

Although it has an algorithm that can count the Z-Score and can classify Stunting or not Stunting news, this information system still does not have the features to provide information related to the calorie requirements of each news especially news belonging to Stunting. In addition to calorie needs, the system has not been able to provide recommendations related to minimum weight and length of a child with a certain age and gender. Because parents will know what the thresholds of the minimum weight and length of the child at a certain age and gender. It is expected that the development of this information system in the future can have features to know the calorie needs of each measurement and this system can also provide information related to the limit of the minimal weight and height for the child affected by Stunting.

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