Cloud Computing Medical Record Related Baby Nutrition Status Anthropometry Index During Postpartum

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***Abstract*—This research introduces new technology in monitoring postpartum health services. This research proposes a system that helps display patient medical record data during the postpartum period. The system uses Cloud Computing (CC) technology for quick calculation of the classification of the nutritional status of infants during postpartum. Database management of nutritional status classification uses virtualization and Web Service (WS) who can manage the resources needed to support multitasking performance. The information obtained is then processed using the method Forward Chaining (FC) to model the patient's condition based on variables of vital signs and classification of nutritional status of children based on Anthropometry Index. The system created has advantages over previous research, using Cloud Computing (CC) Platform as a Service (PaaS) technology. This system is faster and more efficient in reading the monitoring area for classification of infant nutritional status. Data calculation simulations show the initial results that the output obtained is as expected.**

Keywords—Cloud Computing, Web Service, Forward Chaining, Platform as a Services, Postpartum

I. INTRODUCTION

Cloud Computing (CC) is able to play a role in the use of infrastructure directed towards unlimited functionality in storage and mobility to serve many communication network-based devices [1]. The CC paradigm provides a number of benefits through the presence of virtualization technology, which in this section can provide a high-level overview of the benefits of CC in practice. In certain types of virtualization, control and access to the hardware platform that underlies the performance offered to hosted software, development and application flexibility. Virtualization applications can be categorized as hypervisors, also called Virtual Machine Monitors (VMM), which are platforms or applications for running virtualization techniques, which can run several guest OS inside the host OS. With the help of a hypervisor, it seems as if it has a lot of Virtual Computers (VC) [2]. The mechanism for how CC access can be carried out starting from standard access to Local Area Networks (LAN) and intranets with little agent or client applications, to extranet and internet access through a Virtual Private Server (VPS) network which is then generated from Cloud Service (CS), cloud services that have models that allow dynamic embodiment, installation, settings and service rearrangements for use by users [3]. Health world research that utilizes CC technology that has been carried out in telemedicine development, is the development of information services and remote medical services for health consultation [4].

Web Services (WS) is used to support multitasking monitoring systems to facilitate services between users and CC technology [5]. WS stores data information in XML format. So that the data sent can be accessed by other systems even though they are different platforms, operating systems, or even compiler languages. WS can be used to transform one or class businesses and separate objects in one single scope so that the security level can be handled properly. WS is simply uploaded to the server and is ready to be accessed by parties who have been given authorization, thus WS does not require a special configuration on the firewall side [6].

Certainty Factor (CF) is one of the techniques used to assume an expert's degree of confidence in a data. CF introduces the concept of trust and distrust [7]. Forward Chaining (FC) plays a role in finding or drawing conclusions based on existing data or facts leading to conclusions [8]. Monitoring Medical Records produces records and documents regarding patient identity, results of examinations, treatment, other actions and services received by patients [9].

Anthropometry index plays a role in the classification of the basic nutritional status of infants. To get the value of the nutritional status of the baby, the Z-Score value is calculated based on the anthropometric index. indicators of nutritional status in infants set by WHO Child Growth Standards consist of Weight by Age (Weight / Age), Height by Age (Height / Age) and Weight by Height (Weight / Height) [10].

Infant nutrition measurement based on a manual calculation using the Z-Score value of computation cannot be done automatically and does not involve a computer network, so using the FC method is very helpful to determine the Z-Score for infant nutrition classification based on the anthropometric index. Where in the calculation of the Z-Score value, the FC method carries out the process of finding conclusions based on an indicator of the classification of infant nutritional status [11].

In managing data, the most influential factor in the postpartum period medical record data is the Decision Support System (DSS) which can provide information quickly. The CF expert system is very helpful to show the level of trust and the level of distrust of the facts of the data that occur in the field. This system has criteria that the CF value ranges from -1 to 1. The -1 value indicates absolute distrust while the value 1 shows absolute confidence. This value is an indicator of dominant evidence for a hypothesis. A good expert system is

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designed to solve certain problems by imitating the work of experts [12].

Based on the previous description, the combination of CC technology with the CF and FC expert system method is very helpful to solve the problem of monitoring infant nutritional status data based on the anthropometric index in the postpartum period. CC is able to perform data analysis that is very complex by virtualization and expert system methods are able to describe the relationship between fact data on the condition of patients with the expected output of the system to be built [2]. This is very important in building information systems cloud computing where the medical record data is integrated with the CC system which can be done more easily, quickly and accurately.

II. Proposed Method

A. Tools and Materials

Data consists of patient data, midwife data and medical record data (DRM). Patient data consisted of maternal biodata data and baby biodata data. The midwife data consists of midwife biodata data and midwife working area data. DRM data consists of general state data, vital signs data, anthropometric examination data, physical examination data, data on congenital abnormalities, data on childbirth trauma, data on breastfeeding problems, data on indigestion, data on early detection of hearing loss, accompanying alarms, and immunization status data. To synchronize the three data models using PHP and MySQL for the next monitoring system, pre-processing steps are carried out with virtualization for web-based cloud computing.

Data were obtained from Bhakti Bunda clinic healthcare data as a sample of the population of health services for all cities in Central Java Province for the period of 2017-2018. Monitoring focus using twelve parameters contained in the anthropometric examination for this study, the parameters that become criteria using the expert system method consist of weight index according to age include bad nutrition (G01), less nutrition (G02), good nutrition (G03), and more nutrition (G04). Weight index according to height includes very thin nutrition (G05), thin nutrition (G06), normal nutrition (G07), and fat nutrition (G08). Height index according to age includes very short nutrition (G09), short nutrition (G10), normal nutrition (G11) and high nutrition (G12).

B. Research Stages

To achieve the research objectives, there are several steps that have been carried out. Beginning with a literature study as a basis for research. This literature study is related to all problems that occur in infants during the postpartum period which are then used as objects of medical record monitoring research. Identification of detailed descriptions of variables that affect the nutritional classification of infants in the postpartum period. This variable is the basis for designing CC variables.

Cloud computing developers use the Microsoft Azure as a Service (PaaS) Platform based on databases found on localhost which are then included in the cpanel contained in the cloud.

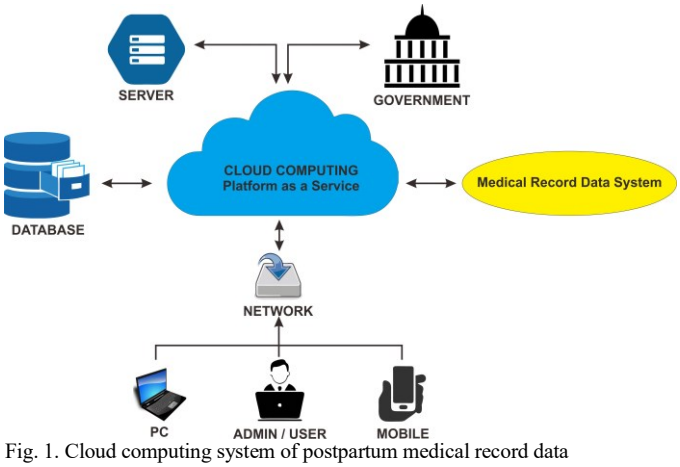

Fig. 1. Cloud computing system of postpartum medical record data

The cloud system built based on Figure 1 consists of a Service App medical record data system, cloud database, and the App Service plan is a cloud server location.

Data processing and analysis were carried out by collecting data consisting of maternal biodata data, baby biodata, and midwife biodata. Expert system analysis of anthropometric index, which determines the three main criteria for nutritional status index based on body weight according to age (Weight / Age), body height according to age (Height / Age) and body weight according to body height (Weight / Age). A decision on the nutritional status of infants is obtained in Table I.

TABLE I. Baby Nutritional Decision

Nutritional Status Code	Z-Score Nutritional Status			
	<-3	<-2	≤2	>2
G01	V			
G02		V		
G03			V	
G04				V
G05	V			
G06		V		
G07			V	
G08				V
G09	V			
G10		V		
G11			V	
G12				V

The next step is to translate the functions in the anthropometry index into the PHP programming language with the following steps [7], [8], [10]:

1. Modeling the Category of Infant Nutrition Status

   In modeling the baby nutritional status category, rule-based is used based on Table 1. Each rule is defined as follows:

   IF Weight_Age is X AND Height_Age is Y (1)

   THEN Weight_Height is Z

   With:

   X (Bad Nutrition, Less Nutrition, Good Nutrition, More Nutrition) is the value of the classification of infant nutritional status based on the indicator Weight / Age, Y

(Very Short Nutrition, Short Nutrition, Normal Nutrition, High Nutrition) is the value of the classification of infant nutritional status based on Height / Age indicator, while Z (Very Thin Nutrition, Thin Nutrition, Normal Nutrition, Fat Nutrition) is the value of the classification of infant nutritional status based on the Weight / Height indicator.

2. Determine the General Z-Score Value

In the anthropometry index, determining the baby's nutrition using the general formula anthropometric index using the Z-Score value. In general, the Z-Score calculation formula is as follows:

$$Z - Score = \frac{Individual\ Value\ Subject - Median\ Standard\ Reference}{Standard\ Reference\ Deviation\ Value} \quad (2)$$

3. Determine the Z-Score Value Weight / Age

To get the value of the nutritional status of the baby, the Z-Score value of the Weight / Age indicator is calculated in Table II.

TABLE II. Z-SCORE INDICATOR WEIGHT / AGE

Gender	Age	Weight (kg)						
		-3 SD	-2 SD	-1 SD	Median	+1 SD	+2 SD	+3 SD
Male	0 Month	2,1	2,2	2,9	3,3	3,9	4,4	5
	1 Month	2,9	3,4	3,9	4,9	5,1	5,8	6,6
Female	Age	Weight (kg)						
		-3 SD	-2 SD	-1 SD	Median	+1 SD	+2 SD	+3 SD
	0 Month	2	2,4	2,8	3,2	3,7	4,2	4,8
	1 Month	2,7	3,2	3,6	4,2	4,8	5,5	6,2

If the value of Z-Score is Positive, the nutritional status is good. On the contrary, if the value of Z-Score is negative, the nutritional status is bad.

4. Determine the Z-Score Value Height / Age

To get the value of the nutritional status of the baby, the Z-Score value of the Height / Age indicator is calculated in Table III.

TABLE III. Z-SCORE INDICATOR HEIGHT / AGE

Gender	Age	Height (cm)						
		-3 SD	-2 SD	-1 SD	Median	+1 SD	+2 SD	+3 SD
Male	0 Month	44,2	46,1	48	49,9	51,8	53,7	55,6
	1 Month	48,9	50,8	52,8	54,7	56,7	58,6	60,6
Female	Age	Height (cm)						
		-3 SD	-2 SD	-1 SD	Median	+1 SD	+2 SD	+3 SD
	0 Month	43,6	45,4	47,3	49,1	51	52,9	54,7
	1 Month	47,8	49,8	51,7	53,7	55,6	57,6	59,5

If the value of Z-Score is Positive then the nutritional status is normal. On the contrary, if the value of Z-Score is negative then the nutritional status is short.

5. Determine the Z-Score Value Weight / Height

To get the value of the nutritional status of the baby, the Z-Score value of the Weight / Height indicator is calculated in Table IV.

TABLE IV. Z-SCORE INDICATOR WEIGHT / HEIGHT

Gender	Height	Weight (kg)						
		-3 SD	-2 SD	-1 SD	Median	+1 SD	+2 SD	+3 SD
Male	50,5	2,7	2,9	3,1	3,4	3,8	4,1	4,5
	60	4,7	5,1	5,5	6	6,5	7,1	7,8
Female	Height	Weight (kg)						
		-3 SD	-2 SD	-1 SD	Median	+1 SD	+2 SD	+3 SD
	50,5	2,7	2,9	3,2	3,5	3,8	4,2	4,6
	60	4,5	4,9	5,4	5,9	6,4	7,1	7,8

If the value of Z-Score is Positive then the nutritional status is normal. On the contrary, if the value of Z-Score is negative then the nutritional status is very thin.

6. System Analysis and Planning

The system to be built uses data input from mother and baby patients who are undergoing postpartum and data on health service midwives based on the work area. The process that will be carried out is WS normal postpartum health services and CC design as an integrated virtualization system between midwives and normal postpartum patients. The output displayed is the result of monitoring the classification of nutritional status of infants in the postpartum period.

C. System Framework

Data parameters will be entered into the database which will then be processed which consists of cloud computing in which there are criteria and rule-based indicators to produce output in the form of a web dashboard consisting of baby nutrition status, baby medical record data, analysis of variables most influences the nutritional status of infants. The system framework can be seen in Figure 2.

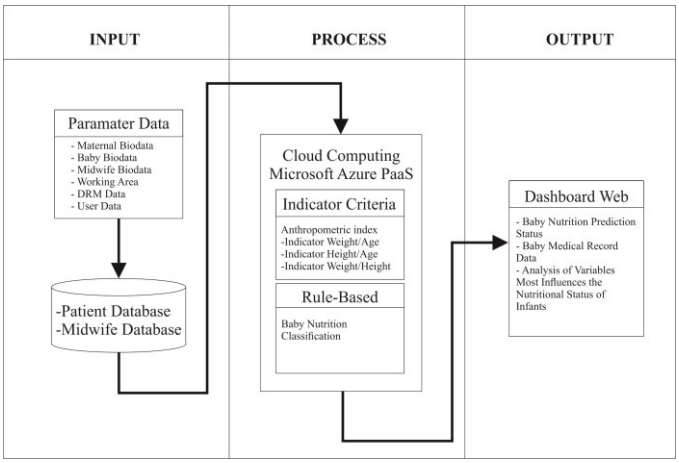

Fig. 2. System framework cloud-anthropometry

III. RESULT AND DISCUSSION

To achieve the research objectives there are several steps that must be done. The stages are divided into several processes, analysis of infant nutrition classification based on general state variables, vital signs, anthropometric examination, physical examination, congenital abnormalities, labor trauma, breastfeeding problems, indigestion, early detection of hearing loss, accompanying danger signs, and immunization status. System implementation, criteria for implementing expert system methods. Continued evaluation of nutritional status classification analysis based on anthropometry index. These stages are very influential in the goal of achieving the system because it has a relationship between the elements used in the study.

By using the forward chaining method, medical record data obtained conclusions about factors that affect the nutritional status of infants during postpartum. As well as recommendations for handling patients (infants) early whether to be observed or done a referral to get medical treatment intensively or specifically intended to do treatment and or care for patients who are critically ill.

Soft system software is developed with the PHP programming language using Wampserver, as an expert system method calculation and Graphical User Interface (GUI) for input and output. Data input, process and output are stored in the MySQL database. All layers within the scope of this system are integrated so as to provide convenience to users in operating this software.

finally, the system of medical record data classification of nutritional status of infants in the postpartum period for monitoring infant nutrition classification using cloud computing technology there is several menus and tag menus that describe each stage of the process.

A. Analysis of Postpartum Infant Medical Record (DRM)

Analysis of the application of cloud computing systems that are used to regulate the medical record data classification of nutritional status in the postpartum period, namely by implementing the baby examination database contained in the database then linked to the database with cloud computing displayed on the status classification system medical record data analysis infant nutrition during postpartum. Based on the results the examination 108 infant patients postpartum period obtained the results of the analysis, the results of the analysis consisted of 52 male infants and 56 female baby patients, obtained from the results during the 7 days of the visit at the time of postpartum infant examination. Where App Service as an application system from the Microsoft Azure cloud. In this study, shows the average response time speed in accessing the system by 168.5ms.

The system built based on Figure 3, shows that application systems built with cloud do not over-occur in data access bandwidth lines. Monitoring the utilization of cloud resources, the percentage of CPU used is only 0.17% of the Storage used by 11.8%.

Monitoring cloud resources based on Figure 4, shows that web computing carried out in the cloud can overcome data resources in large capacity or big data. The App Service plan is the server location of the cloud, the average CPU speed for cloud computing access is 3% and the memory used is 53.08%.

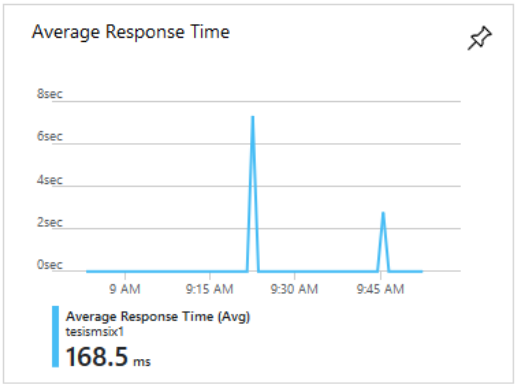

Fig. 3. The average response time of cloud computing

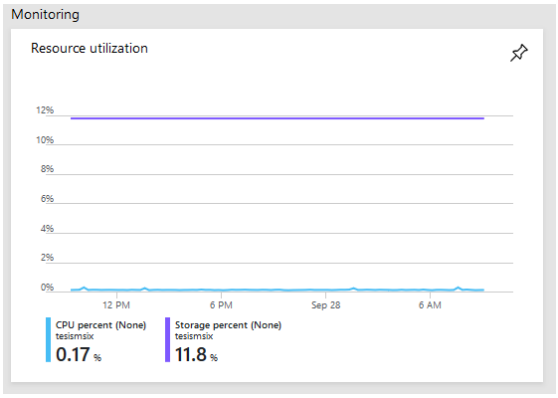

Fig. 4. Monitoring the utilization of cloud resources

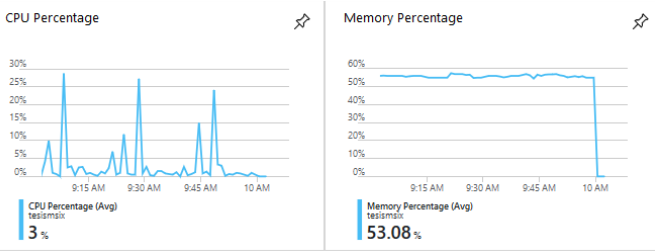

Fig. 5. Monitoring app service plan performance

The performance monitoring of the App Service plan is based on Figure 5, demonstrating that cloud servers are able to deal with large-scale data computing on a large scale and that memory requirement in computing data from cloud servers do not overload their usage capacity. So that cloud computing can technically help analysis of nutritional classification quickly and efficiently in determining the nutrition of infants in the postpartum period.

The percentage of baby infection 3.6%, baby hypothermia medium 22.8%, baby dehydration 1.5%, baby icterus 3.6%, problematic baby breastfeeding 7.5%, baby digestive disorders 5.1%, baby breathing problems 3.6%, baby congenital abnormalities 22.6%, childbirth trauma babies 20.9%, and baby is not immunized 8.7%. So, the most influential factor in the postpartum infant medical record data is baby hypothermia medium 22.8% and baby congenital abnormalities 22.6%. Baby medical record data can be seen in Figure 6.

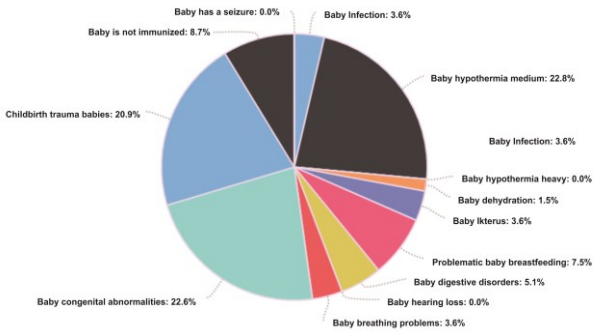

Fig. 6. Baby Medical Record Data

B. Baby Nutrition Status Weight / Age

Based on the results of an analysis of the nutritional status of infants carried out for 7 days for 52 male infants and 56

female baby patients, nutritional status was obtained based on weight indicators according to age, can be seen in Table V.

TABLE V. NUMBER OF BABY NUTRITION WEIGHT / AGE

Gender	Weight/Age			
	Bad Nutrition	Less Nutrition	Good Nutrition	More Nutrition
Male	1	2	47	2
Female	1	1	50	4
Total	2	3	97	6

Based on Table V, it was found that the results of baby boy experienced bad nutrition as much as 1 person, baby girl experienced bad nutrition as much as 1 person, baby boy experienced less nutrition as much as 2 people, baby girl experienced less nutrition as much as 1 person, baby boy experienced good nutrition as much as 47 people, baby girls experienced good nutrition as much as 50 people, baby boys experienced more nutrition as much as 2 people, baby girls experienced more nutrition as much as 4 people. Furthermore, the percentage of Weight / Age infant nutritional status in Figure 7 was obtained.

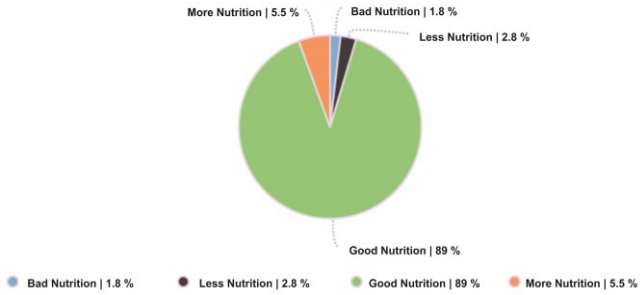

Fig. 7. Percentage of Baby Nutrition Status Weight / Age

Based on the percentage of infant nutritional status, the indicator of Weight / Age showed 1.8% of infants experiencing bad nutrition, 2.8% of infants experienced less nutrition, 89% of infants experienced good nutrition and 5.5% of infants experienced more nutrition. So, the most dominant nutritional status of infants is the baby has a good nutrition status of 89%.

C. *Baby Nutrition Status Weight / Age*

Based on the results of an analysis of the nutritional status of infants carried out for 7 days for 52 male baby patients and 56 female baby patients, the results of nutritional status were based on height indicators according to age, can be seen in Table VI.

TABLE VI. NUMBER OF BABY NUTRITION HEIGHT / AGE

Gender	Height/Age			
	Very Short Nutrition	Short Nutrition	Normal Nutrition	High Nutrition
Male	3	6	28	15
Female	5	9	30	12
Total	8	15	58	27

Based on Table VI, the results of the baby boy experienced very short nutrition as much as 3 people, the baby girl experienced very short nutrition as much as 5 people, the baby boy experienced short nutrition as much as 6 people, baby girl experienced short nutrition as much as 9 people, baby boy men experienced normal nutrition as much as 28 people, baby girls experienced normal nutrition as much as 30 people, baby boys experienced high nutrition as much as 15 people, baby girls experienced high nutrition as many as 12 people. Then obtained the percentage of Height / Age infant nutritional status in Figure 8.

Based on the percentage of nutritional status of Height / Age indicator infants, the results obtained 7.3% of infants experienced very short nutrition, 13.8% of infants experienced short nutrition, 53.2% of infants experienced normal nutrition and 5.5% of infants experienced more nutrition. So, the nutritional status of the most dominant baby is that the baby has a normal nutrition status of 53.2%.

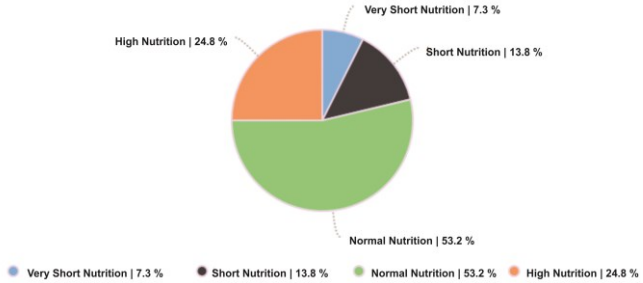

Fig. 8. Percentage of Baby Nutrition Status Height / Age

D. *Baby Nutrition Status Weight / Height*

Based on the results of an analysis of the nutritional status of infants carried out for 7 days for 52 male infants and 56 female baby patients, nutritional status was obtained based on indicators of weight indicators according to height, can be seen in Table VII.

TABLE VII. NUMBER OF BABY NUTRITION WEIGHT / HEIGHT

Gender	Weight/Height			
	Very Thin Nutrition	Thin Nutrition	Normal Nutrition	Fat Nutrition
Male	27	8	19	1
Female	29	7	16	1
Total	56	15	35	2

Based on Table VII, the results of the baby boy experienced very thin nutrition as much as 27 people, the baby girl experienced very thin nutrition as much as 29 people, the baby boy experienced thin nutrition as much as 8 people, baby girl experienced thin nutrition as much as 7 people, baby boy experienced normal nutrition as much as 19 people, baby girls experienced normal nutrition as much as 16 people, baby boys experienced high nutrition as much as 1 people, baby girls experienced high nutrition as much as 1 people. Then obtained the percentage of Weight / Height infant nutritional status in Figure 9.

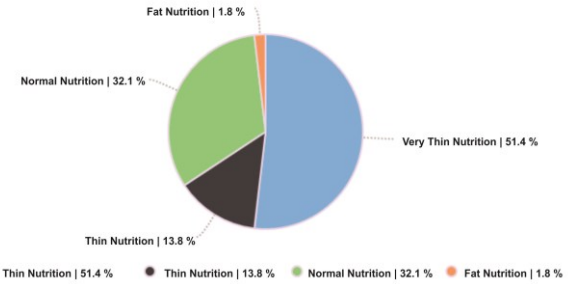

Fig. 9. Percentage of Baby Nutrition Status Weight / Height

Based on the percentage of infant nutritional status of Weight / Height indicator, it was found that 51.4% of infants experienced very thin nutrition, 13.8% of infants experienced thin nutrition, 32.1% of infants experienced normal nutrition and 1.8% of infants experienced fat nutrition. So, the most

dominant nutritional status of infants is that babies have the very thin nutritional status of 51.4%.

IV. Conclusion

From the results of the study, in monitoring normal postpartum medical record data using cloud computing in detecting the most influential factors in postpartum period medical record data. The Forward Chaining method is very helpful in determining the Z-Score value for infant nutrition classification based on the anthropometric index. The application system is built with the average cloud speed response time in accessing the system by 168.5ms. This shows that there is no excessive lag in the data access bandwidth. Web computing that is done in the cloud percentage of CPU that is used is only 0.17% of the Storage used by 11.8%, so web computing can overcome if the data resources are in large capacity. Cloud servers are able to cope with computing data with an average CPU speed for access to cloud computing by 3% and memory used by 53.08% indicates that servers with fast computing access speeds on a large scale and memory requirements in computing data from cloud servers do not overload capacity use it. The results of anthropometric index analysis obtained the most influential factor in the postpartum period medical record data is baby hypothermia medium 22.8% and baby congenital abnormalities 22.6%. Infant nutrition classification obtained from nutritional analysis based on anthropometric index of 108 infant patients, during 7 days of postpartum examination, the most dominant nutritional status was babies experienced good nutrition status of 89% based on Weight / Age indicator, babies experienced normal nutrition status of 53.2% based on Height / Age indicator dan babies experienced very thin nutrition status of 51.4% based on Weight / Height indicator.

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