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THE MAPPING OF MALNUTRITION AND STUNTING THROUGH WEB-BASED SUPPORT SYSTEM

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Abstract

Information on changes in weight of the children-under-five has been a parameter for mapping potential malnutrition problems. However, that is not enough. Besides the weight, the body height is also important information. This is related to the problem of stunting in Indonesia. The prevalence is quite large and spread in several areas. The Indonesian government has made a policy to overcome the malnutrition and stunting problem by establishing The posyandu (integrated healthcare centre). The posyandu is coordinated by puskesmas (community health centre) to observe the children. However, in fact, some children are not observed because the benefits of posyandu services are not taken by their parents. In addition, the recorded data is not directly state condition of the community health. The data mining algorithm could be used to indicate nutritional status. It is conducted through information on the weight and height of children for estimate the community health status. This paper focuses on finding a support system model that could be used for it. The result is a web-based support system model, which generate the map and the community health status. Thus, it is an input for the government and stakeholder to improve health of the children and the community.

***Keywords*:** Algorithm, Data-Mining, Posyandu, Public-Health.

1. Introduction

Malnutrition and stunting are complex issues that draw the attention of the world (Philipson et al., 2014) and many researchers. Their effects can be devastating and can impact a child for the rest of his or her life. As a consequence of potentially irreversible cognitive damage, stunted children may be slower to learn and less likely to reach their full potential (Lutter & Lutter, 2014). It is one indicator of potential slowed national development. World Bank research suggests that, on average, countries lose 7 percent of the per capita GDP because they did not eliminate stunting when their current workers were children (The World Bank: IBDA/IDA, 2018). Malnutrition does not occur suddenly, but begins with insufficient weight gain. For these reasons, the health and nutritional status of children is one of the benchmarks that can indicates the nutritional condition of the wider community, because the pattern of parenting in many communities more priority to their children (Finn, 2014).

Information on changes in weight of the children weight has been a parameter for mapping potential health problems. Bambang Lareno(Lareno et al., 2018)has made a model to overcome this with weight based only, but it is not enough. Besides the weight, the body height is also important information. This is not only malnutrition, but related to the problem of stunting in Indonesia. The prevalence is quite large and spread in several areas (Figure 1).

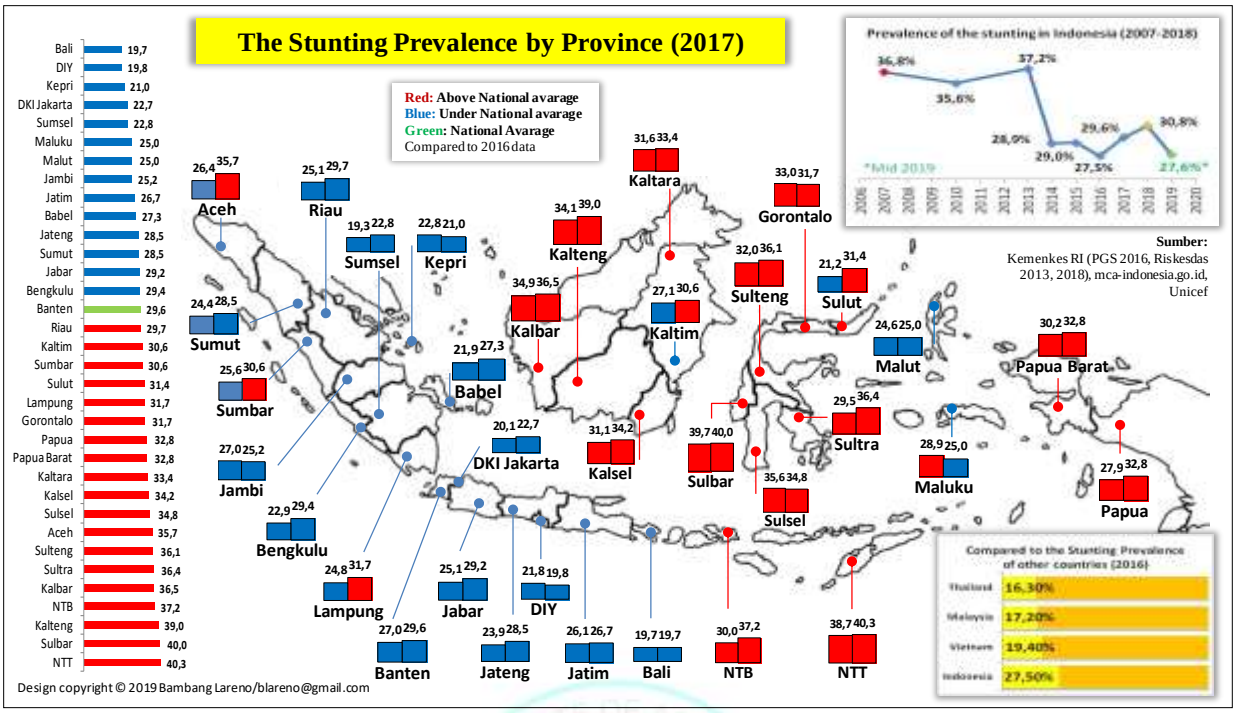


Figure 1: Stunting prevalence of the children-under-five of Indonesia (Badan Litbangkes, 2018)

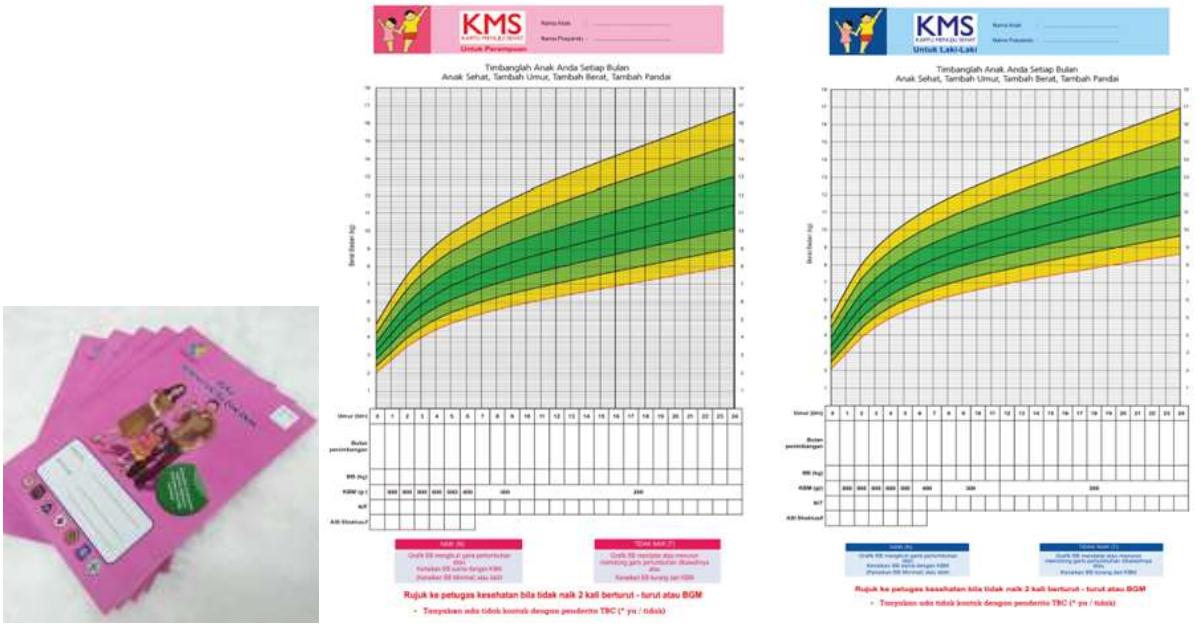


Figure 2: The KIA (MNCH) Book, containing KMS sheets(Left).
The KMS for girl (middle), and the KMS for boy (right)

The Indonesian government has made a policy to address malnutrition issues through the establishment of the posyandu (pos pelayanan terpadu/ integrated healthcare centre) under the coordination of the puskesmas (pusat kesehatan masyarakat/community health centre). The posyandu is an integrated service post to monitor the growth of children-under-five, health of pregnant and lactating women. The aim is that growth is observed and the data is recorded in KMS (Kartu Menuju Sehat/Growth Indicator Card). The KMS model is shown in Figure 2.

Although in fact, not all children are observed, because there are parents who are reluctant to take advantage of Posyandu services. In addition, the recorded data are not state directly of the conditions of community health.

Zhiwu Liu (Liu & Zhang, 2010), using classification rules and prediction models to mark students, describes how predictive analysis results can be used to determine factors that may affect students so that some negative studentbehaviour or behaviour can be detected and corrected on time. The ability of classification algorithms to mark like this has been used to mark the nutritional status of children-under-five in the territory of each posyandu(Swastina & Lareno, 2014)or the territory of each puskesmas (Swastina et al., 2014).

Thus, this paper focuses on finding a support system model that can be used to mark the posyandu, recognize growth indicators, generate children growth status, produce the map, and the common status of community health.

2. Research Method

The system is not complex, but it is still possible to change after implementation based on evaluation and user input. So, this design refers to the Systems Development Life Cycle (SDLC) model(Dennis et al., 2013), including: requirement gathering, investigate the current system, identify possible improvements and develop a concept for new system.

3. Requirement gathering

The system to be developed is a system of information that can be updated (and validated) by posyandu attendant. Posyandu becomes system primary input point. In addition, given the wide range of territory, but affordable for signals, posyandu attendants must be able to access and update data via smart-phone. In order to the support system is able to quickly provide valid and accurate information.

Functionally, the support system can:

- receive input data from web or mobile apps android based.
- identify who is filling the data.
- extract the requested information through web pages as well as mobile android apps.
  Non-functional:
- The core system (e-ppgbm) runs in a windows environment, the support system can run in windowsor mobile apps environments.
- The system can validate every process of inputting data and data requests.
- The system is expected to respond to requests in less than 60 seconds.
- The system can support user to modify (CRUD) their data in real-time easily.

4. Investigate the Current System

Growth indicators are used to assess growth considering a child's age and measurements together. The SKDN indicators are weight-for-age based. The SKDN data in the form of four columns of numbers namely S (the number of children-under-five in work area), K (the number of children-under-five with KMS), D (the number of children-under-five present to be weighed), N (the number of children-under-five weighed 2 months in a row and the growth line on KMS goes up but does not move to thecolour line below it), and BGM (Bawah Garis Merah/the number of children-under-five have growth line under red line, -3rd SD).The BB/U is weight-for-age and the TB/U is length/height-for-age.

The study used the data SKDN, obtained from Posyandu Purnama Sari of Puskesmas S. Parman. Other data of posyandu in the same puskesmas was obtained from Puskesmas S.Parman.Similardata was obtained from Puskesmas: Sei-Bilu, Pekauman, Alalak Tengah, dan

Basirih Baru. The SKDN data of Puskesmas in other region, obtained from Banjarmasin Health Office.

These SKDN, BB/U dan TB/U data are recorded and collected monthly by local Posyandu attendant or authorized officers from the Puskesmas. Data is processed at the Puskesmas, then data is entered into the e-ppgbm system (Kementerian Kesehatan RI, 2018), in addition to paper-based reporting. Periodically, Puskesmas reports data to city/district health offices. Then, the data is stored, sorted and processed again per sub district. In one sub-district, there may be one or more Puskesmas.

In paper-based recording and reporting, there are at least three important points:

- It takes time to reach the city or district level and it takes time to get the area that needs attention.
- Error interpretation of recorded data and filling errors in KMS.
- Possible changes in data when reporting at each level. In addition, there is a possibility that the paper will be damaged or lost.

The Ministry of Health has actually provided the e-ppgbm. This is a further step after the government has conducted the PSG (nutritional status monitoring) survey since 2016. 2018 is a year of transition from PSG survey to e-ppgbm. Total data collected (2018); there were only 3,906,430 out of 23,729,538 toddlers by BPS(Badan Pusat Statistik, 2018). From the total data, there are 3,139,615 which have been recorded by BB/U and TB/U. From the recorded data (by Name, by Address), there are 761,837 stunting toddlers. It is expected that in 2019, total coverage can be achieved. The main input point is still at the Puskesmas.

But, in fact, the data is not filled immediately. They are filled monthly (this is quite normal) and there are three monthly filling, and some even filling six monthly. Some reasons are: staff are limited and more allocated to health services, can not immediately because there is a lot of recording paper and need accuracy when entering data into the e-ppgbm system, and BB/U is measured monthly but the height of a toddler (TB/U) is not significant in a month so it is difficult to measure so it is measured quarterly.

Therefore, to simplify the input/output data process, and updating in real time, it is necessary to system that can run in a mobile apps environment. Input/output data could be done through android application (smart-phone) and or web page. This has also been provided, but has not functioned optimally.

4. Identify Possible Improvements

Identify possible of improvement is divided into two parts, i.e.the utilization indicators of Posyandu and support for interpreting the individual growth indicator. Based on this information, the support system model that can be used to generate the map of malnutrition and stunting then made the estimation of community health.

4.1. The Utilization Indicator of Posyandu

Posyandu has several levels of recognition: Pratama, Madya, Purnama and Mandiri. The level is based on several indicators (Table 1). Therefore, the SKDN data needs to be further processed in the form of proportions such as D/S, etc. Data processed to obtain trend value:

- Level of program coverage, Proportion P1: K/S
- Utilization rate or participation, Proportion P2: D/S
- Nutrition level or programachievement, Proportion P3: N/D
- Dropout rate, Proportion P4: (K-D)/K
- Malnutrition level, Proportion P5: BGM/D

In addition, the number and proportion of active Posyandu, as shown in figure 3.

Table 1: The Posyandu Indicator and levels of recognition

Indicators	Pratama	Madya	Purnama	Mandiri
Health Cadres	< 5	5 or more		
Weigh Frequency	< 8/year	8/year or more		
D/S Avarage	< 50%		> 50%	
KIA (MNCH/maternal, neonatal and children health) Coverage	< 50%		> 50%	
KB (Birth Control) Coverage	< 50%		> 50%	
Immunization Coverage	< 50%		> 50%	
Additional Program	(-)		(+)	
Healthy Fund Coverage	<50%			>50%

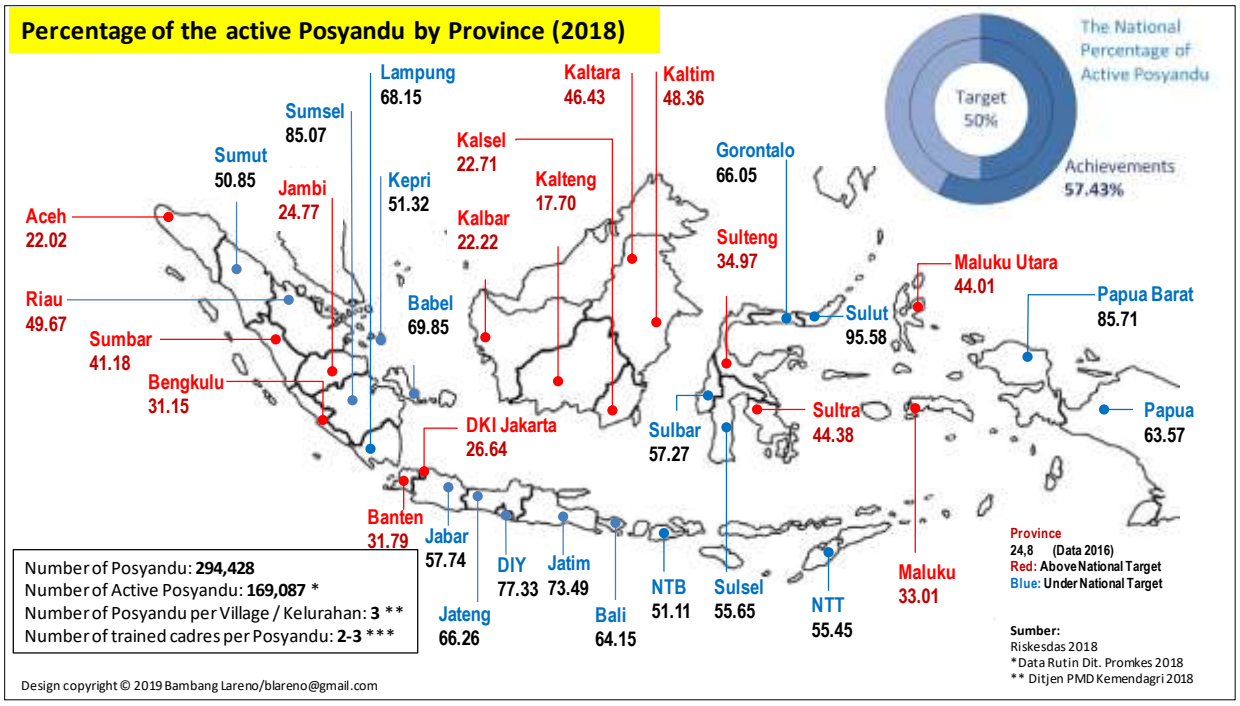


Figure 3: Percentage of the active Posyandu of Indonesia

4.2. Interpreting the Individual Growth Indicator

The specific charts used will depend on the toddler's age, which determines whether the child will stand for measurement of height or lie down for measurement of length. The measurements will be plotted on growth charts in the Boy's KMS or the Girl's KMS so that trends can be observed over time and any growth problems identified (see Figure 2).

Weight-for-age (BB/U) reflects body weight relative to the toddler's age on a given day. This indicator is used to assess whether a child is underweight or severely underweight, but it is not used to classify a child as overweight or obese. Weight-for-age charts for two age groups: 0 to 24 month and 25 to 60 month.

Following the standard of WHO (World Health Organization and UNICEF, 2009), Length/height-for-age (TB/U) reflects attained growth in length or height at the toddler's age at a given visit. This indicator can help identify children who are stunted (short) due to prolonged

under nutrition or repeated illness.Length/height-for-agecharts for three group of age: 0 to 6 months; 6 to 24 months; and 25 to 60 months.

As well, Weight-for-length/height (BB/TB) reflects body weight in proportion to attained growth in length or height. This indicator is especially useful in situations where ages of children are unknown. The (BB/TB) is help to identify children with low weight-for-height who may be wasted and severely wasted. Wasting is usually caused by a recent illness or food shortage that causes acute and severe weight loss (Department of Nutrition for Health and Development, WHO, 2008).

Based on the indicators above, the growth problems represented (shown in Table 2) as:

- stunted, severely stunted
- underweight, severely underweight
- wasted, severely wasted
- possible risk of overweight, overweight, obese

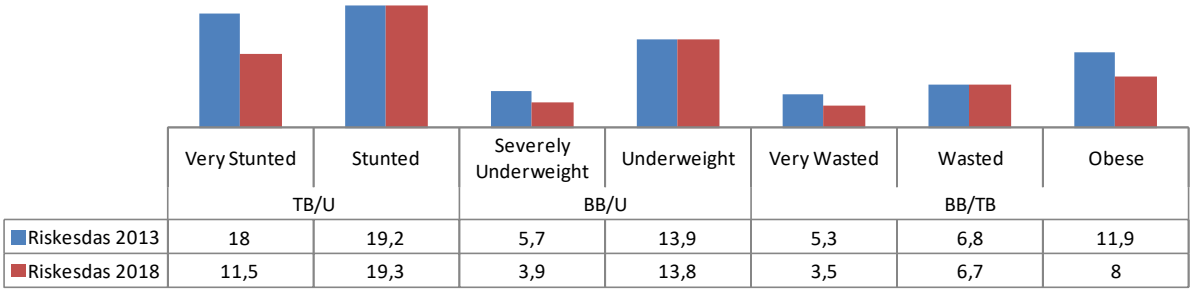
Whereas the nutritional problems of children under five in 2013 (Badan Litbangkes, 2013) to 2018 (Badan Litbangkes, 2018)are reflected in the prevalence rates (shown in Figure 1 and Figure 5), which in some cases have improved.

Table 2: The Growth Indicators

<table>
<tr><td rowspan="2">Z-score</td><td colspan="3">Growth Indicator</td></tr>
<tr><td>TB/U</td><td>BB/U</td><td>BB/TB</td></tr>
<tr><td>Above 3</td><td>Very tall.</td><td rowspan="2">May have a growth problem better assessed from BB/TB</td><td>Obese</td></tr>
<tr><td>Above 2</td><td rowspan="3">Normal</td><td>Overweight</td></tr>
<tr><td>Above 1</td><td rowspan="2">Possible risk of overweight</td></tr>
<tr><td>0 (Median)</td><td rowspan="2">Normal</td></tr>
<tr><td>Below -1</td><td>Normal</td></tr>
<tr><td>Below -2</td><td>Stunted**</td><td>Underweight</td><td>Wasted</td></tr>
<tr><td>Below -3</td><td>Very Stunted**</td><td>Severely underweight</td><td>Very Wasted</td></tr>
</table>

* Tallness is rarely a problem unless it is so excessive that it may indicate an endocrine disorder

** It is possible for a stunted or severely stunted child to become overweight



	Very Stunted	Stunted	Severely Underweight	Underweight	Very Wasted	Wasted	Obese
	TB/U		BB/U		BB/TB		
Riskesdas 2013	18	19,2	5,7	13,9	5,3	6,8	11,9
Riskesdas 2018	11,5	19,3	3,9	13,8	3,5	6,7	8

Figure 4: Prevalence of Toddler Nutrition Problems in 2013 and 2018

5. Develop a Concept for New System

The support system was developed primarily to avoid data filling errors due to inaccurate staff perceptions and data plots on KMS, duplicate data, or incomplete due to tiered data collection. This system will produce a large amount of data on the growth of children under five and also

the use of Posyandu, as input for a map model of potential malnutrition and the general status of public health.

Data is stored and processed on the server, as part of supporting support to facilitate the filling of e-ppgbm data. Input and data requests made by users are validated through a mobile application, or web page. So that input and output can be done by cross platforms (Figure 4).

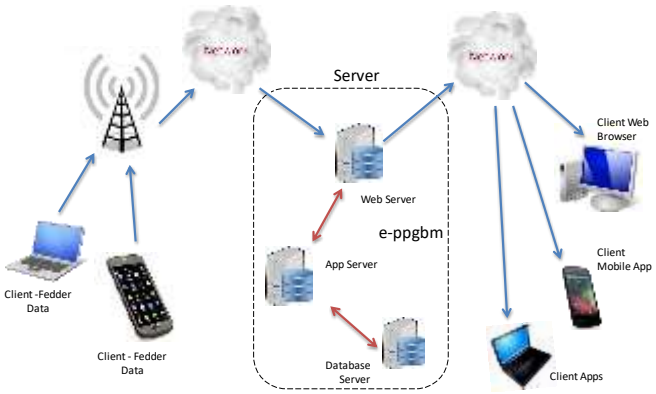


Figure 4: The supporting system model

The data mining proposed model for mapping the common status of community health is a classification with C4.5 Algorithm, which will be implemented using Rapid miner 5.3.Decision Tree C4.5 Algorithm Stages (Swastina et al., 2014):

1. Prepare training data.
2. Determine the roots of a tree calculated using equation 1:

$$Entropy\ (S) = \sum_{i=1}^{n} - pi * \log_2 pi \qquad (1)$$

3. Calculate the Gain value using equation 2:

$$Gain(S, A) = Entropy(S) - \sum_{i=1}^{n} \frac{|S_i|}{|S|} * Entropy(S_i) \qquad (2)$$

4. Repeat step 2 until all tuples are partitioned
5. The decision tree partition process will stop when:
   - All tuples in node N get the same class
   - No attributes in tuples are partitioned anymore
   - There are no tuples in the empty branch

6. Result and Discussion

Based on rapid-miner output, decision trees based on data P1, P2, P3, P4 and P5 of Posyandu can be used for public health status map, because it has an accuracy of up to 87.5%. Like also for malnutrition and stunting map, which are based on BB/U, TB/U, BB/TB, P3 and P5, which can reach 90% accuracy.

Examples of data used and outputs of C4.5 (in color map) for each Posyandu in the puskesmas area and data for each puskesmas in Banjarmasin region are shown in table 3 and 4. The same goes for the provincial and national levels. The red, amber, yellow and green are associated with the common community health in high risk, medium risk, moderate risk, and low risk.

In Table 3, even though the coverage was 100% and the number of children with BGM was only 1, the community in the Posyandu Purnama working area was marked as having high risk health. Only 17 (34%) of children were weighed, and only 10 (58.82%) were weighed. This is because the awareness of the local community to utilize health facilities is still lacking. Their children's growth is not monitored. When this happens (unchanged or worsening), they may be having problems: water quality and sanitation, food fortification, access to health services, childcare education, nutrition knowledge, and reproductive health education.

Table 3: The SKDN, Proportion and Result of Puskesmas S. Parman

							P1	P2	P3	P4	P5	C.45
NO	POSYANDU	S	K	D	N	BGM	K/S	D/S	N/D	(K-D)/K	BGM/D	Result (in color map)
1	Purnama Sari	50	50	17	10	1	100,00%	34,00%	58,82%	66,00%	5,88%	Red
2	Mulia Sari	101	98	93	88	0	97,03%	92,08%	94,62%	5,10%	0,00%	Green
3	Mekar Sari	84	84	66	65	2	100,00%	78,57%	98,48%	21,43%	3,03%	Amber
4	Indah Sari	100	80	83	81	0	80,00%	83,00%	97,59%	-3,75%	0,00%	Yellow
5	Mayang Sari	97	97	80	70	1	100,00%	82,47%	87,50%	17,53%	1,25%	Amber
6	Maya Sari	99	99	77	77	0	100,00%	77,78%	100,00%	22,22%	0,00%	Yellow
7	Restu Ibu	72	72	61	61	1	100,00%	84,72%	100,00%	15,28%	1,64%	Amber
8	Antasan Indah I	121	121	103	101	0	100,00%	85,12%	98,06%	14,88%	0,00%	Yellow
9	Antasan Indah II	154	154	131	127	0	100,00%	85,06%	96,95%	14,94%	0,00%	Yellow
10	Antasan Indah III	158	150	140	130	0	94,94%	88,61%	92,86%	6,67%	0,00%	Green
11	Antasan Indah IV	133	133	120	116	0	100,00%	90,23%	96,67%	9,77%	0,00%	Green
	S. Parman	**1169**	**1138**	**971**	**926**	**5**	**97,35%**	**83,06%**	**95,37%**	**14,67%**	**0,51%**	**Yellow**

Table 4: The SKDN, Proportion and Result of Banjarmasin

							P1	P2	P3	P4	P5	C.45
No	Puskesmas	S	K	D	N	BGM	K/S	D/S	N/D	(K-D)/K	BGM/D	Result (in color map)
1	Kayu Tangi	2.203	2.203	1.753	1.703	15	100,00%	79,57%	97,15%	20,43%	0,86%	Amber
2	Alalak Selatan	2.805	2.799	2.316	2.089	7	99,79%	82,57%	90,20%	17,26%	0,30%	Yellow
3	Alalak Tengah	2.526	2.526	1.924	1.325	30	100,00%	76,17%	68,87%	23,83%	1,56%	Amber
4	Sei Jingah	4.134	4.134	3.196	2.521	26	100,00%	77,31%	78,88%	22,69%	0,81%	Amber
5	Pelambuan	3.683	3.683	2.025	1.294	2	100,00%	54,98%	63,90%	45,02%	0,10%	Amber
6	Banjarmasin Indah	1.445	1.445	1.022	852	9	100,00%	70,73%	83,37%	29,27%	0,88%	Yellow
7	Basirih Baru	1.933	1.933	1.368	1.330	16	100,00%	70,77%	97,22%	29,23%	1,17%	Yellow
8	Kuin Raya	3.166	2.611	1.766	1.273	14	82,47%	55,78%	72,08%	32,36%	0,79%	Amber
9	Teluk Tiram	1.798	1.798	1.432	1.367	8	100,00%	79,64%	95,46%	20,36%	0,56%	Yellow
10	Terminal	2.180	2.180	992	879	3	100,00%	45,50%	88,61%	54,50%	0,30%	Red
11	9 Nopember	1.274	1.274	1.050	539	9	100,00%	82,42%	51,33%	17,58%	0,86%	Red
12	Cempaka Putih	2.375	2.375	1.744	1.641	12	100,00%	73,43%	94,09%	26,57%	0,69%	Green
13	Sei Bilu	861	854	521	307	39	99,19%	60,51%	58,93%	38,99%	7,49%	Red
14	Pekapuran Raya	1.387	1.387	750	653	13	100,00%	54,07%	87,07%	45,93%	1,73%	Amber
15	Karang Mekar	1.047	1.047	830	738	14	100,00%	79,27%	88,92%	20,73%	1,69%	Yellow
16	Pemurus Baru	2.365	2.365	1.891	1.769	18	100,00%	79,96%	93,55%	20,04%	0,95%	Green
17	Pemurus Dalam	1.793	1.793	903	552	8	100,00%	50,36%	61,13%	49,64%	0,89%	Amber
18	Kelayan Dalam	857	857	529	292	21	100,00%	61,73%	55,20%	38,27%	3,97%	Amber
19	Kelayan Timur	2.019	2.019	1.599	1.483	43	100,00%	79,20%	92,75%	20,80%	2,69%	Amber
20	Pekauman	4.666	4.548	3.634	3.373	46	97,47%	77,88%	92,82%	20,10%	1,27%	Yellow
21	Beruntung Raya	715	715	499	411	22	100,00%	69,79%	82,36%	30,21%	4,41%	Red
22	S. Parman	1.169	1.138	971	926	5	97,35%	83,06%	95,37%	14,67%	0,51%	Yellow
23	Sei Mesa	1.253	1.253	1.105	1.011	11	100,00%	88,19%	91,49%	11,81%	1,00%	Yellow
24	Gadang Hanyar	1.583	1.583	1.294	1.099	31	100,00%	81,74%	84,93%	18,26%	2,40%	Amber
25	Cempaka	1.307	1.307	995	929	18	100,00%	76,13%	93,37%	23,87%	1,81%	Yellow
26	Teluk Dalam	2.296	2.296	1.706	1.027	6	100,00%	74,30%	60,20%	25,70%	0,35%	Amber
	Banjarmasin	**52.840**	**52.123**	**37.815**	**31.383**	**445**	**98,64%**	**71,57%**	**82,99%**	**27,45%**	**1,18%**	**Yellow**

While the work-area of Mulia Sari is marked as low risk, although the coverage is not 100%, public awareness in utilizing Posyandu is high, as evidenced by the number of children who weight gained was 88 out of 93 (92.62%).

Overall, Puskesmas S.Parman is received a moderate-risk label, where: the coverage was 97.35%; the participation was 83.06%; the program achievement was 95.37%; and the

malnutrition was 0.51%. Then total in regionally, Banjarmasin received a moderate-risk label (shown in Table 4), with: the coverage was 98.64%; the participation was 71.57%; the program achievement was 82.99%; and the malnutrition was 1.18%.

As for growth indicators, the results follow the usual logic algorithm. Every minimum two data inputted the application could plot points and lines on the appropriate growth graph. Thus, at the time of the first data inputted, the application provides labels and information according to the guidelines in Table 2. At the time of the second data input, the application provides growth trend: improve, unchanging or worsen.

Thus, the information can be used as input for the government and public policy makers to improve the health of children and the community, both specific and sensitive interventions (TNP2K, 2018).The estimate of health condition is useful for making sensitive intervention. Sensitive intervention aimed at the community through various development activities outside the health sector. These include the provision of clean water; the improved sanitation; the education on care and nutrition; the reproductive health education; the access to health facilities and health insurance; the food availability and diversity program. On the other hand, the growth indicators of children are useful for carrying out specific nutritional interventions. It aimed at children within the first 1000 days. These include the maternal food supplements during pregnancy; the micronutrient supplements or fortification for mothers and children; the breast milk and complementary foods; the feeding behavior and stimulation; the management of acute cases of malnutrition; the prevention and management of diseases.

Conclusion

The cross-platform information model that was developed is a web-based core system (e-ppgbm), with the addition of a mobile application-based support system. The support system was modeled with presupposes that the posyandu is used as an input point. The support system design outcome is the easiness of data filling. Therefore, the process of data updating from posyandu must be real-time. The system can deliver the estimates of general status of public health and growth label of the children. Thus, it is an input for government and stakeholders to improve health of the children and the community, both specific and sensitive interventions.

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