ORIGINAL ARTICLE

Bali Medical Journal (*Bali MedJ)* 2022, Volume 11, Number 3: 1176-1179
P-ISSN.2089-1180, E-ISSN: 2302-2914

Comprehensive sanitation situation analysis based on complete components in community-based total sanitation

Abdul Hakim Zakkiy Fasya[1*], Mursyidul Ibada[1], Dwi Handayania[1]

ABSTRACT

Introduction: Although research to analyze the sanitation situation in Indonesia has been intensively carried out, the results of this research are not sufficient to show aspects of community behavior comprehensively based on the components in total community-based sanitation (STBM). A recent study based solely on the availability of sanitation facilities and community affordability found that weak financial support allocated to address sanitation problems was a key factor. Therefore, this study aimed to analyze the sanitation situation comprehensively based on the components in STBM.

Methods: This research was conducted in 34 provinces in Indonesia. All areas were selected so that a complete and comprehensive analysis could be carried out. The data used in this study is secondary data obtained from the Basic Health Research and the Indonesian Demographic and Health Survey (IDHS). Cluster analysis using Fuzzy C-Means (FCM) was performed to cluster sanitation conditions based on the parameters of healthy latrine use; handwashing behavior and facilities; safe drinking water and food management; management of household waste and its facilities; and safe household liquid waste management.

Results: It is found that the value for cluster 1 does not have priority problems in terms of environmental health. There is only one indicator, namely littering, which is above the national average. While in cluster 2, the complexity of the problem is more complex where almost all indicators are above the national average, only the indicators of carelessly throwing garbage and disposing of feces are below the national average. Cluster 3 has complex problems in no defecation, no defecation, no sewerage, and littering. These areas are included in the priority sanitation intervention program; Bangka Belitung, North Sulawesi, Southeast Sulawesi, Gorontalo, West Kalimantan, Central Kalimantan, West Nusa Tenggara, South Kalimantan, Maluku, Central Sulawesi and East Nusa Tenggara.

Conclusions: This study determines the classification of sanitation conditions to provide comprehensive information on which areas are included in the priority sanitation intervention program. The novelty and contribution of this research is a comprehensive analysis based on the components of STBM, which has never been done before.

Keywords: community-based total sanitation, fuzzy c-means clustering, sanitation classification.
Cite This Article: Fasya, A.H.Z., Ibad, M., Handayani, D. 2022. Comprehensive sanitation situation analysis based on complete components in community-based total sanitation. *Bali Medical Journal* 11(3): 1176-1179. DOI: 10.15562/bmj.v11i3.3536

[1]Universitas Nahdlatul Ulama Surabaya, Indonesia;

*Corresponding author:
Abdul Hakim Zakkiy Fasya;
Universitas Nahdlatul Ulama Surabaya, Indonesia;
abdul.hakim@unusa.ac.id

Received: 2022-07-16
Accepted: 2022-08-12
Published: 2022-09-13

INTRODUCTION

Since 1993 sanitation has become a concern in Indonesia. It showed by the existence of studies that examine access to water resources, from rural to urban areas. Over time, not only access to water supply, but world attention (through WHO and the World Bank) also highlighted the management of liquid waste in 2000, by encouraging government commitments which were finally followed-up through the BAPPENAS program.[1]

In fact, in 2011 the Indonesian government stated that it would increase the budget allocation by 3.1 billion dollars annually to improve access to water supply and 1.4 billion dollars to improve public sanitation access.[2] In 2012, the government's attention increased by increasing focus on liquid waste management. In 2012, the government's attention increased by increasing focus on liquid waste management. However, until 2016, only 1% of the community had access to such sanitation.[3] In 2020, as a result of the Covid-19 pandemic, sanitation facilities will not only have an impact on physical construction but also reduced sanitation services from sanitarians. This is due to limitations on mobilization and budget cuts, by at least 2% of provinces in Indonesia.[4] Studies conducted by WHO, World Bank, UNICEF, and the Australian Agency for International Development (AusAID) only found financing constraints on sanitation access problems in Indonesia. This is based on the availability of sanitation facilities and community affordability.[1–4]

Research that has been carried out related to the analysis of the sanitation situation in Indonesia has only found weak financial support allocated to address sanitation problems.[3] Sanitation that is in the spotlight is only based on the availability of sanitation facilities such as the quantity and quality of clean water and drinking water, proper latrines, and household liquid waste has not shown aspects of community behavior, according

to the complete component in total community-based sanitation (STBM).[2,5] If a holistic analysis is carried out based on STBM, then clustering of districts/cities based on their sanitation conditions will result in complete information related to sanitation conditions in Indonesia.

This study uses the variables in the complete Community-Based Total Sanitation (STBM) component[5], based on data from the Basic Health Research[6–9] and the Indonesian Demographic and Health Survey (IDHS) to analyze the sanitation situation. Provincial level in Indonesia, so that it can be used as a reference for determining the appropriate intervention program in stages.[10]

The results of this study will determine the classification of sanitation conditions to provide comprehensive information on which areas are included in the priority sanitation intervention programs, as well as what programs are needed by the area so that they can more effectively address sanitation problems. The novelty and contribution of this research is a comprehensive analysis based on the complete components of STBM, which has never been done before.

METHODS

Study Design

The type of research conducted is a cross-sectional study that used secondary data from Basic Health Research in 2019 and IDHS in 2017.

Data Collection

The data used in this study were sourced from Basic Health Research in 2019 and IDHS in 2017 about the community-based total sanitation variable on a provincial scale throughout Indonesia. The variables used are stopping open defecation, washing hands with soap, safe drinking water/food management, household waste management, and liquid waste management. The procedures carried out are:

1. Prepare the data used in clustering.
2. Determine the number of clusters (c), weighting power (w = 2), smallest expected error (ξ = 10−5), initial objective function (P0 = 0) and initial iteration (t = 1).
3. Generating initial membership degrees.
4. Calculate the center of the cluster, calculate the objective function of iteration to "t", and update the value of the degree of membership.
5. The iteration process stops for the value of |Pt – Pt−1| < ξ, if not then repeat step 4.
6. Determine the optimum number of clusters by using the validity index.
7. Determine the optimum cluster member using the membership degree based on the highest value.
8. Interpretation of grouping results and cluster characteristics.

Data Analysis

Fuzzy C-Means (FCM) is one of the fuzzy clustering algorithms. Fuzzy C-Means (FCM) is a data clustering technique in which the existence of each data point in a cluster is determined by the degree of membership. This technique was first introduced by Jim Bezdek in 1981. The output of FCM is a series of cluster centers and several degrees of membership for each data point. The advantage of the Fuzzy C-Means method is the precise placement of the cluster center based on the degree of inclination of the cluster members.[11] So, it is more suitable for social data that does not have a definite set. The algorithm of Fuzzy C-Means is as follows:

1) Input the data to be grouped, namely X in the form of a matrix measuring n x m (n = number of data samples, m = attributes of each data). Xij i-th sample data (i=1,2,….,n), jth attribute (j=1,2,…,m).
2) Determine the number of clusters (c), the rank for the partition matrix (w), the maximum iteration (MaxIter), the smallest expected error (ε), the initial objective function (P0=0), and the initial iteration (t=1).
3) Generate random numbers ik, i=1,2,… ,n; k=1,2,…,c as elements of the initial partition matrix U. Counting the number of each column that can be seen in equations (1) and (2):

$$Q_j = \sum_{k=1}^{c} \mu_{ik} \quad (1)$$

Count

$$\mu_{ik} = \frac{\mu_{ik}}{Q_j} \quad (2)$$

4) Calculate the center of the k-th cluster: Vkj, with k=1,2,…,c; and j=1,2,…,m. The determination of the cluster center is used to mark the average location for each cluster with inaccurate initial conditions. Using equation (3):

$$V_{ij} = \frac{\sum_{k=1}^{n}((\mu_{ik})^{w} * X_{kj})}{\sum_{k=1}^{n}(\mu_{ik})^{w}} \quad (3)$$

5) Calculate the objective function at the t-th iteration. Pt : the calculation of the objective function is used to describe the distance from a given data point to the center of the cluster which is weighted by the degree of membership of the data point, using equation (4):

$$P_t = \sum_{k=1}^{N}\sum_{i=1}^{c}\left(\left[\sum_{j=1}^{m}(X_{ik} - V_{kj})^2\right](\mu_{ik})^2\right) \quad (4)$$

6) Calculate the change in the partition matrix using equation (5):

$$\mu_{ik} = \frac{\left[\sum_{j=1}^{m}(X_{ij} - V_{kj})^2\right]^{\frac{-1}{w-1}}}{\sum_{k=1}^{c}\left[\sum_{j=1}^{m}(X_{ij} - V_{kj})^2\right]^{\frac{-1}{w-1}}} \quad (5)$$

With i=1,3,…,n; and k=1,2,…,c.

7) Check the stop condition:
If: $(|P_t - P_{t-1}| < \varepsilon)$ (t > MaxIter) then stop. If not: t = t+1, then repeat step 4

RESULTS

After clustering analysis, we obtain the result as below.

DISCUSSION

Based on the above results, it is found that the value for cluster 1 does not have priority problems in terms of environmental health. There is only one indicator, namely littering, which is above the national average. While in cluster 2, the complexity of the problem is more complex where almost all indicators are above the national average, only the indicators of carelessly throwing garbage and disposing of feces are below the national average. Then cluster 3 also has the same value, although the condition is slightly improved compared to cluster 2. Cluster 3 has complex problems in no defecation, no defecation, littering, littering, no sewerage, and littering.

If you look at the picture, it can be seen in the picture that there are areas where the provinces have slices of problems in clusters 2 and 3. These provinces

Table 1. **Sanitation situation based on Community-Based Sanitation Program indicator.**

Indicator	National Mean	Cluster 1	Cluster 2	Cluster 3
There is no defecation facility	11.08	3.56	12.66	17.42
Defecation is not in the latrine	11.80	6.97	12.66	16.12
Lack of sanitation facilities	63.20	34.52	70.32	69.99
Wrong way to wash hands	50.20	40.80	56.99	55.48
Poor access to clean water	34.72	20.44	39.65	37.56
Poor access to drinking water	26.32	14.30	30.60	28.97
Unhealthy food management	62.08	47.84	69.89	60.04
Open trash bin	77.90	75.10	79.32	73.94
Littering	13.70	7.22	13.14	26.37
No Wastewater Sewer	69.90	69.65	69.91	78.66
feces thrown carelessly	33.50	38.40	31.86	44.19

Green color : below national prevalence
Yellow color : above the national prevalence but not the highest
Color red : above the national prevalence, the highest

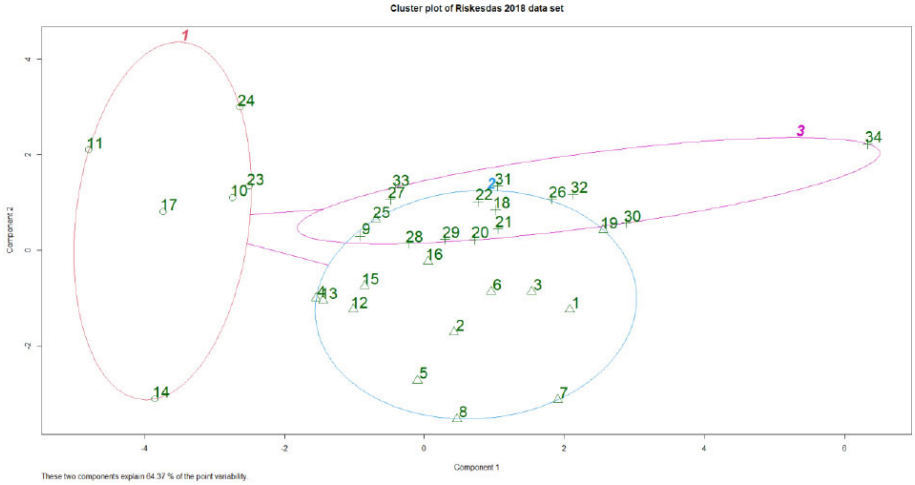

Figure 1. Sanitation situation based on Fuzzy C-Means clustering.

include: Bangka Belitung, North Sulawesi, Southeast Sulawesi, Gorontalo, West Kalimantan, Central Kalimantan, West Nusa Tenggara, South Kalimantan, Maluku, Central Sulawesi and East Nusa Tenggara.

CONCLUSION

This study determines the classification of sanitation conditions to provide comprehensive information on which areas are included in the priority sanitation intervention program. These areas are Bangka Belitung, North Sulawesi, Southeast Sulawesi, Gorontalo, West Kalimantan, Central Kalimantan, West Nusa Tenggara, South Kalimantan, Maluku, Central Sulawesi and East Nusa Tenggara. The novelty and contribution of this research is a comprehensive analysis based on the components of STBM, which has never been done before.

DISCLOSURE

Author Contribution

All authors have contributed to this research process, including conception and design, analysis and interpretation of the data, drafting of the article, critical revision of the article for important intellectual content, final approval of the article, collection and assembly of data.

Funding

This research was done with support of Universitas Nahdlatul Ulama Surabaya for sponsorship fund.

Conflict of Interest

There is no conflict of interest for this manuscript.

Ethical Consideration

This research was approved by the Health Research *Ethics* Committee of Mathematics and Sciences Faculty of Garut University. Letter of exemption Ref. No. 11.7768/NU.22/LL/2022

ACKNOWLEDMENT

We sincerely thank to Nahdlatul Ulama Surabaya University for sponsorship fund.

REFERENCES

1. (AusAID). AA for ID. EAST ASIA PACIFIC REGION, URBAN SANITATION REVIEW, INDONESIA COUNTRY STUDY. 2013.
2. World Bank. Water Supply and Sanitation in Indonesia: Turning Finance into Services for the Future. 2014;
3. UNICEF EAPRO. Equity in Public Financing of Water, Sanitation and Hygiene (WASH) INDONESIA. 2016. p. 11–39.
4. Engagement C. Indonesia COVID-19 Response Situation Report. 2020;(October).
5. Indonesia KKR. Pedoman Pelaksanaan Teknis STBM [Internet]. 2012. p. 1–72. Available from: http://stbm.kemkes.go.id/public/docs/reference/5b99c4c2576e12f4c9a2019139312658b2f3704c9abc5.pdf
6. Kemenkes. Laporan Nasional Riskesdas 2007. 2007. p. 1–384.
7. Riskesdas. Riset Kesehatan Dasar; Badan Penelitian dan Pengembangan Kesehatan Kementerian Kesehatan RI Tahun2010. Lap Nas 2010. 2010;1–446.

8. KemenKes RI. Riset kesehatan dasar (Riskesdas) 2013. Jakarta Badan Penelit dan Pengemb Kesehat Kementrian Kesehat Republik Indones. 2013;
9. Badan Penelitian dan Pengembangan Kesehatan. Laporan Nasional RISKESDAS 2018. 2019;198.
10. Kemenkes RI. Survey Demografi dan Kesehatan Indonesia. Survei Demografi dan Kesehatan Indonesia 2017. 2017. 147–178 p.
11. Bezdek JC, Ehrlich R, Full W. FCM: The fuzzy c-means clustering algorithm. Comput Geosci. 1984;10(2–3):191–203.