

SANITATION VALUE CHAIN

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CONTENTS

Preface

.....Yamauchi, T. and Sintawardani, N. 005

Keynote speeches:

The Hyper-Thermophilic Composting Sewage Sludge and the Ash Alkali Composting Feces are Excellent Organic Fertilizers for the Sustainable Agriculture

.....Matsui, S. 007

Urine: The Potential, Value Chain and Its Sustainable Management

.....Viskari, E.-L., Lehtoranta, S. and Malila, R. 010

Implementation of Kangpisman Program for Zero Waste in Bandung City

.....Hidayat, G. G. S. 013

Oral presentations:

Applying an Integrated Framework for Improving Sanitation Uptake and Sustainability in Rural Karangasem, Bali

.....Dwipayanti, N. M. U. 016

Soap Liquid Waste due to Covid-19 Pandemic in Magelang City: Challenges and Recommendations

.....Arifin, M. Z. and Maizunati, N. A. 018

Application of Upflow Anaerobic Sludge Blanket (UASB) Reactor Technology for Wastewater Treatment: Technical, Environmental and Socio-Economic Assessment in Developing Countries

.....Arthur, P. M. A., Konate, Y. and Sawadogo, B. 020

CONTENTS

Used of Black Shale Adsorbent for the Removal of Sodium Adsorption Ratio (SAR) from GreywaterSangare, D., Coulibaly, S. L., Fofana, M. and Coulibaly, L.	022
The Impact of COVID-19 Prevention Measures on Water Quality: An Indonesian PerspectiveWidyarani, Komarulzaman, A., Wulan, D. R., Rosmalina, R. T., Hamidah, U. and Sintawardani, N.	024
Physical and Mental Health of Sanitation Workers in an Urban Slum of Indonesia: Personal Hygiene and the Construction of Self-Esteem in Waste-HandlingSai, A., Al Furqan, R., Ushijima, K., Hamidah, U., Ikemi, M., Widyarani, Sintawardani, N. and Yamauchi, T.	026
Hazard Analysis and Critical Control Point (HACCP) of Food Stall on Campus in Yogyakarta, IndonesiaAsmara, A. A., Abidin, A. U., Putri, S. R. P. and Asmarany, A.	028
Identification of Key Zero Waste Management Indicators for West JavaSundana, E. J., Nastiti, A. and Sutadian, A. D.	030
Socio-Demographic and Sanitation Factors Associated with Diarrhea Prevalence in Peri-Urban Lusaka, ZambiaNyambe, S., Agestika, L. and Yamauchi, T.	032
Determine the Benefits of Changes in Community Attitudes and Their Participation in the Community- Based Water Supply and Sanitation Program (PAMSIMAS) in Landak Regency, IndonesiaPanjaitan, A. A. and Purba, C. S.	034
Twinning Programme: Learning from Horizontal Learning on Domestic Wastewater Treatment in Three Districts in South SulawesiSetiabudi, W.	036
Development of Community Behaviours Towards Clean Sanitation to Reduce Stunting Prevalence: A Case StudyRomadona, M. R., Febrianda, R., Dinaseviani, A. and Budiansyah, A.	038
Poster presentations:	
Analysis of Methane Production from Septage Sludge of Various AgeInayah, R., Islami, B. B. and Priadi, C. R.	040

CONTENTS

Evaluation of Communal WWTP Performance Based on Technology Management in Kabupaten Sleman D.I. YogyakartaRahmawati, S., Luthfi, Z. H., Yulianto, A. and Wantoputri, N. I.	041
Loading Rate Estimation of Wastewater from Batik Industry in Yogyakarta Area, IndonesiaJuliani, A., Rahmawati, S., Wacano, D., Setianto, A. I., Abdillah and Yoneda, M.	042
Improvement of Municipal Waste Management Using Dynamics System and Zero Waste Index Approaches in Bandung CityChristiady, J., Widyarsana, I. M. W., Sutadian, A. D. and Sundana, E. J.	043
Current Overview of Polyethylene Terephthalate as Biofilm Media in Communal Wastewater Treatment Plants in IndonesiaNur, A., Soewondo, P., Oginawati, K. and Setiyawan, A. S.	044
Association of Fecal Contamination and WASH Conditions in a Zambian Peri Urban CommunityChua, M. L., Harada, H., Tsurumi, M., Fujii, S., Nyambe, I., Chirwa, M. and Yamauchi, T.	045
Exploration and Identification of Novel Anammox Bacteria in IndonesiaZulkarnaini, Komala, P. S., Putra, R. P., Yamamoto-Ikemoto, R., Matsuura, N., Koike, K. and Ali, M.	046
Preliminary Study on the Potential Utilization of Oil Palm Biomass for Tissue Paper: A Life Cycle PerspectiveSetiawan, A. A. R., Putra, A. S., Sari, A. A., Wiloso, E. I. and Noguchi, R.	047
The Quantity, Quality, and Treatment of Wastewater from the Tofu Industry in Giriharja, Sumedang, West Java, IndonesiaLubis, D. M., Astuti, D. I., Dwiartama, A., Sintawardani, N. and Hamidah, U.	048
Interventions for Last Mile Districts: Achieving 100% ODF in Pangkep District in South SulawesiSetiabudi, W.	049
The Urgency of Water Resources License Rule in Anjongan Area, West Kalimantan ProvincePurba, C. S. and Panjaitan, A. A.	050
Co-Creation Practices on Sanitation in the Communities of CameroonHayashi, K., Shimizu, T., Harada, H., Etoga, S.=P., Nsonkali, C.-J., Messe, V., Mbarga, G., Zobome, C. G., Nakao, S. and Yamauchi, T.	051

CONTENTS

Perceptions and Potential Reuse of the Effluent from Anaerobic Wastewater Treatment Plant (WWTP) Treated Tofu Wastewater	Untari, M., Noor, E., Widyarani, Sintawardani, N. and Hamidah, U.	052
Assessment of The Impact of Toluene Exposure on Urinary Hippuric Acid Concentration of Batik Workers in Special Region of Yogyakarta, Indonesia	Anka, A. A. H., Oginawati, K., Febriana, S. A., Tanziha, I. and Prakoeswa, C. R. S.	053
Assessment of Sanitation, Hygiene and Health Status of Primary School Children in a Zambian Slum	Dinala, H., Nyambe, S. and Yamauchi, T.	054
An Assessment of Sustainable Solid Waste Management and Occupational Health in Lusaka, Zambia	Sambo, J., Muchindu, M., Nyambe, S. and Yamauchi, T.	055
Menstruation and Menstrual Hygiene Management Practices among Females in an Urban Slum of Indonesia	Sato, K., Widyarani, Hamidah, U., Ikemi, M., Ushijima, K., Sintawardani, N. and Yamauchi, T.	056
Infant Oral Contact and Alloparenting in a Hunter-Gatherer Society in Cameroon	Konishi, T., Hayashi, K. and Yamauchi, T.	057
Knowledge, Attitude, and Practice of Hygiene Associated Gross Motor Development Delay among Children in a Suburban Area of China	Zeng, Y., He, J., Hao, M., Han, W. and Yamauchi, T.	058
Financial Feasibility of Scheduled Desludging Service in Tangerang Regency, Banten	Masia, R. and Nastiti, A.	059
The Ethics of Sanitation: Its Realms and Prospects	Nakao, S.	060

*Proceedings of the Online International Symposium
on the Sanitation Value Chain 2020 (SVC2020)*

Preface

We are honored to bring you this collection of abstracts from the Online International Symposium on the Sanitation Value Chain 2020 (SVC2020), which was held virtually from 9th to 10th December 2020.

The primary focus of this symposium was to bring together researchers from all around the world for knowledge sharing in various areas of Global Sanitation. In this regard, the SVC2020 served as a valuable platform for the scientific community, where almost 200 participants from nine countries met to exchange their ideas. During the two days of the symposium, the researchers presented the most recent discoveries in Global Sanitation through their oral and poster presentations.

On behalf of the scientific board, we would like to thank the participants who have contributed to the volume, which is a collection of abstracts from 12 oral and 21 poster presentations. We also express our heartfelt gratitude to the keynote speakers, Prof. Saburo Matsui (Japan), Dr. Eeva-Ilisa Viskari (Finland), and Mr. Gun Gun Saptari Hidayat (Indonesia). Lastly, we are most indebted for the generous support given towards SVC2020 by staff from the Indonesian Institute of Science (LIPI), Indonesia and the Research Institute for Humanity and Nature (RIHN), Japan.

5th February 2021

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The Hyper-Thermophilic Composting Sewage Sludge and the Ash Alkali Composting Feces are Excellent Organic Fertilizers for the Sustainable Agriculture

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Keywords: probiotic environmental agriculture, bacteria diversities, human waste, plant growth-promoting rhizobacteria, urine-feces separation toilet, hyper-thermophilic compost

This lecture discusses how to connect human waste to agriculture as organic fertilizers safely, by referring two different composting methods. The important and common concept is the probiotic environmental agriculture (Figure 1).

First method is the hyper-thermophilic composting method, which was developed for composting sewage sludge in Japan (Figure 2). This method is now recommended to install wastewater treatment plants in the name of BISTRO sewage works by the department of sewage works of Ministry of Land, Infrastructure, Transport and Tourism (MLIT). Farmers utilize the organic fertilizer and harvest high quality crops by saving fertilizer cost, and enriching soil fertility and the diversity of the farming environment.

Second method is the urine and feces separation toilets, those have been constructed more than 1,300 unites in Malawi and Kenya by a Japanese international NGO, NICCO for the last decade (Figure 3). The success of this sanitation approach attributes to the improvement of agricultural economy as well as health conditions of many families. Urine is an excellent liquid fertilizer with optimum dilution. Feces are stored in container boxes under a toilet for a half year, where after each defecation, a cup of ash is thrown over the feces which are fermented in the alkali condition by the ash from a cooking stove of a family.

It is very interesting that when I compared the bacteria diversities between the sewage and the feces organic fertilizers, both share a similarity that is also found in the diversity of plant growth-promoting rhizobacteria (PGPR) (Figure 4). This may imply why the organic farming is successful. Properly composted sewage sludge and feces can be excellent organic fertilizer as well as properly composted animal dungs. Phosphate rocks are a crucial limiting nutrient for the sustainable agriculture. We have to recycle and save phosphate nutrient for next generations.

My answer;

The probiotic environmental agriculture

- That promotes production and use of high quality compost from variety of organic wastes by **new composting technologies**;
An example. hyper-thermophylic composting
- High quality compost must contain nutrients, that **replaces chemical fertilizer**, and **beneficial microorganisms** that **replaces pesticides**.
- The **probiotic environmental agriculture** also promotes uses of beneficial bacteria of **many single species**, that can promote growth of plants, and suppress harmful bacteria, fungi, nematodes and insects.

Figure 1. Concept of the probiotic environmental agriculture.

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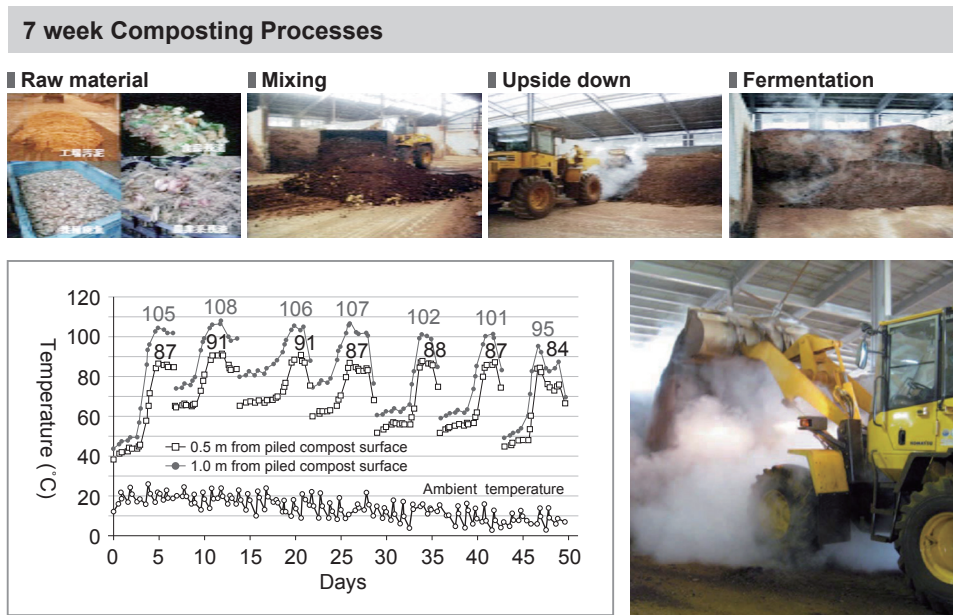


Figure 2. Process of hyper-thermophilic composting method in Japan.

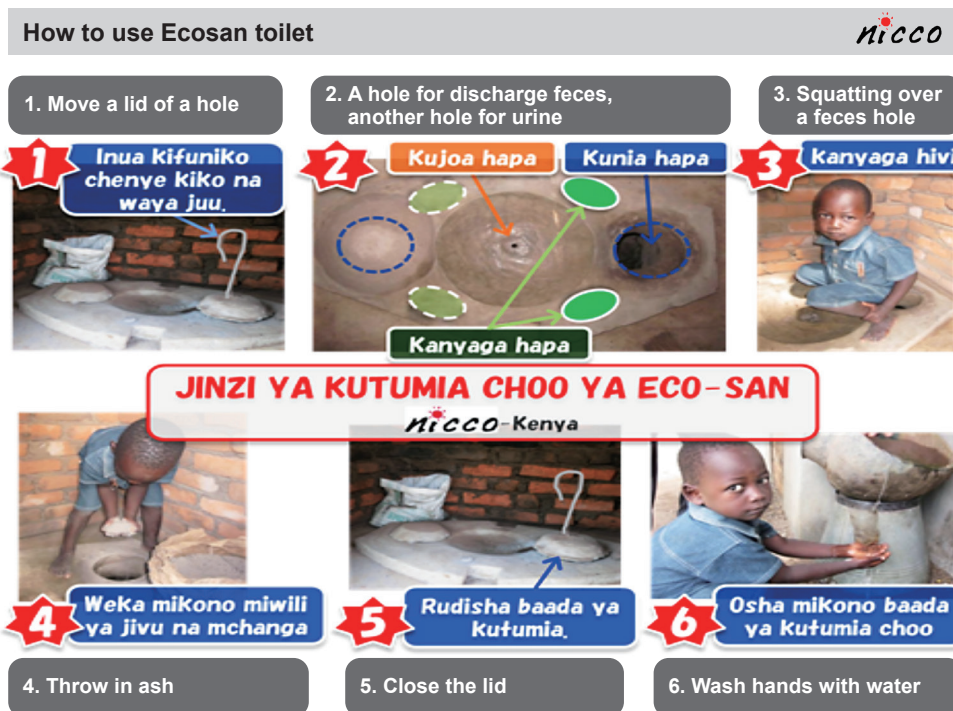


Figure 3. Urine and feces separation toilet in Africa.

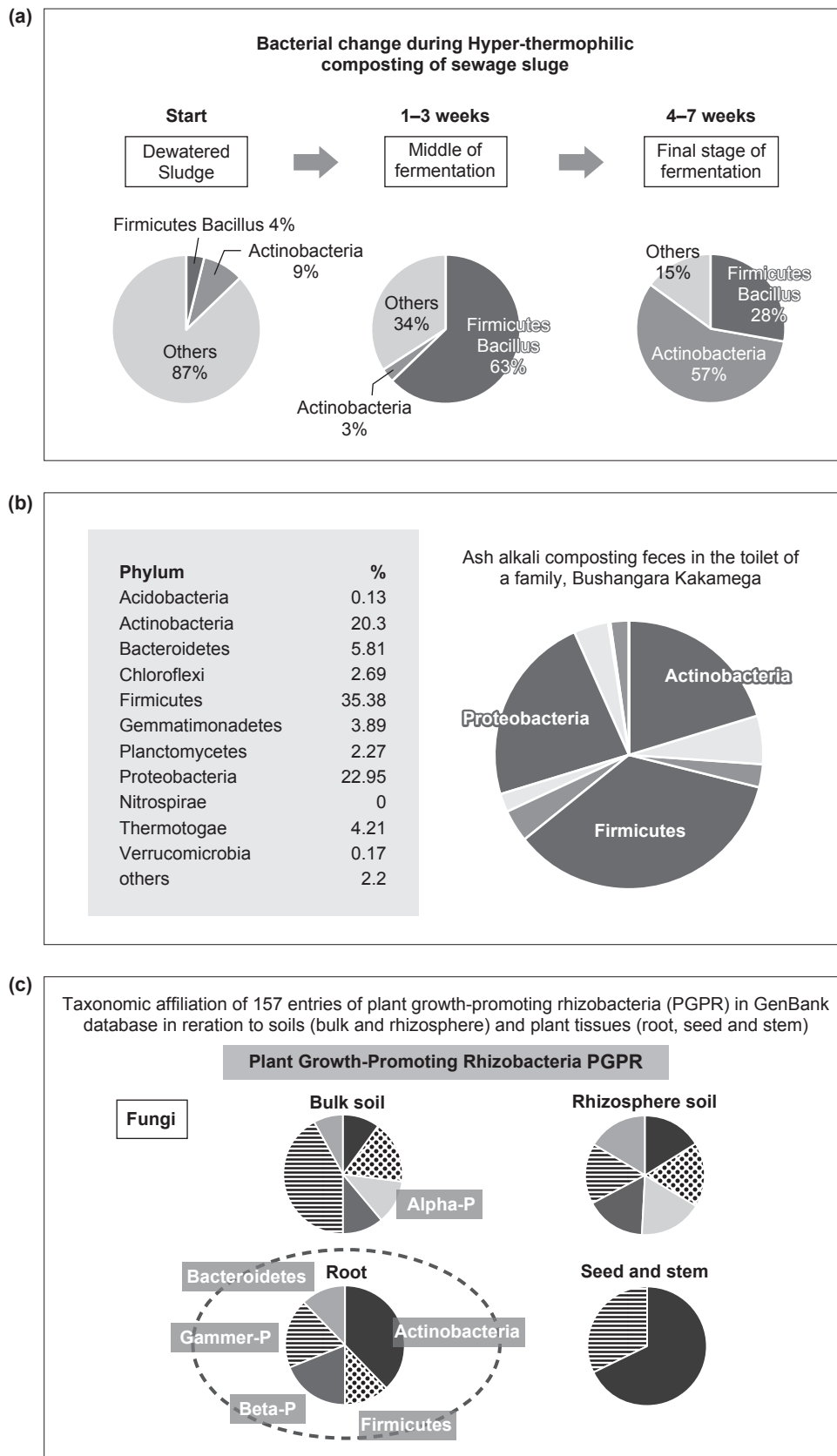


Figure 4. (a) Bacteria diversities in hyper-thermophilic composting of sewage sludge. (b) Urine and feces separation toilet. (c) Plant growth-promoting rhizobacteria.

Urine: The Potential, Value Chain and Its Sustainable Management

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Keywords: urine, fertilizer, value chain, agriculture, nutrient recovery

Phosphorus and nitrogen are essential nutrients in crop cultivation and there is ever increasing demand for the use of them in food production. Phosphorus is a fossil mineral and it is estimated that there is only a limited time left to mine affordable and relatively easily extractable phosphate rock (Cordell et al. 2009; 2011). Furthermore, the production of nitrogen fertilisers is highly energy intensive (Viskari et al. 2018a, b). Therefore, we need to look for more efficient ways for nutrient reuse in agriculture. There are many nutrient rich biomasses that can be used as organic fertilizers in agriculture. These include animal manure and sludge, green manure, sewage sludge, septic tank sludge, different side streams from food industry and biowastes.

From the wastewater stream urine forms only about 0.6% by volume but holds about 80% of all the nitrogen and phosphorus (Van der Hoek et al. 2018), which reveals the importance of urine as a nutrient source. Globally, about 80% of the wastewaters are discharged to the environment without adequate treatment (World Bank 2020). In wastewater treatment process, in turn, the emphasis currently is in nutrient removal, not in nutrient recovery per se. Source separated human urine offers one option for nutrient reuse. Urine can be diverted from the solid excreta and it can be used as a liquid fertiliser. Fertilizer efficiency and use of source separated human urine has been studied and demonstrated already for decades. In many research studies the efficiency and safety of urine as a fertilizer has been shown promising results compared to the use of mineral fertilizers (e.g., Pradhan 2010; Viskari et al. 2018a).

As the fertilizer efficiency of source separated human urine has been demonstrated repeatedly, it has also been found to be an environment friendly fertilizer. Applying source-separation systems in rural areas, enables up to four times more phosphorus and over thirty times more nitrogen recovered compared to the current on-site wastewater treatment systems. Furthermore, eutrophication impact is reduced to one fifth. There is a risk, however, of increased soil acidification but it can be minimized with advanced urine spreading techniques. These include for example deep injection of the urine to the soil. Life cycle analysis (LCA) and environmental impact analysis (EIA) indicates that urine diversion and utilization as a fertilizer in agriculture protects the natural water bodies from waste pollution and eutrophication (Viskari et al. 2018a; Malila et al. 2019).

An issue of concern in urine reuse is the risk of spreading pathogens and harmful substances like heavy metals and pharmaceuticals to the environment. Urine contains only those substances that we are exposed to via our diet, inhalation or skin contact. Urine has been found to contain about 3000 different substances also naturally (Bouatra et al. 2013). In our studies, we found urine to contain the most common pharmaceuticals, hormones and some other micropollutants. Out of the total amount of 239 analysed organic compounds, such as phenolic compounds, phthalates, alkylphenols and ethoxylates, pesticides, PFC compounds, pharmaceuticals and hormones we were able to identify 30 compounds exceeding the detection limit of the analysis method. None of these were found in

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the soil or the barley grain at the end of the growing season when using urine as a fertilizer (Viskari et al. 2018b). Only exception was progesterone, which plants can also produce endogenously (Janeczko et al. 2013). Despite the fact, that source separated urine, when treated according to WHO (2006) guidelines, does not seem pose a risk to environment or human health (Table 1), there is still resistance and biased attitudes against the use of it. Therefore, the research communication is crucial in providing scientific and unbiased information about the characteristics of urine as a fertilizer.

Fertilizer use of source separated urine as such is feasible in the vicinity of the source, without long-distance transportation needs. This is not, however, always possible. Recent research studies are, therefore, concentrating more on management and treatment of urine on-site to concentrate it, decrease the volume or recovering the nutrients from it. Recovering the nutrients in energy and resource efficient way would enable more efficient utilization of the separated urine. There are many potential technologies to treat the urine for nutrient recovery (Figure 1). Recovering the nutrients from urine would also help in the acceptance of the fertilizers use as the original source of nutrients can no longer be seen in the actual fertilizer product.

Table 1. Summary of the amounts of micropollutants, pharmaceuticals and hormones found from urine. (Viskari et al. 2018b)

Micropollutant	Analyzed #	Found exceeding the detection limit		
		Urine	Soil	Grain
Phenolic compounds	46	7	0	0
Phtalates	10	3	0	0
Alkylphenols and ethoxylates	11	0	0	0
Pesticides (incl. triclosane)	93	1	0	0
PFC-compounds	24	0	0	0
Pharmaceuticals and hormones	55	19	0	1

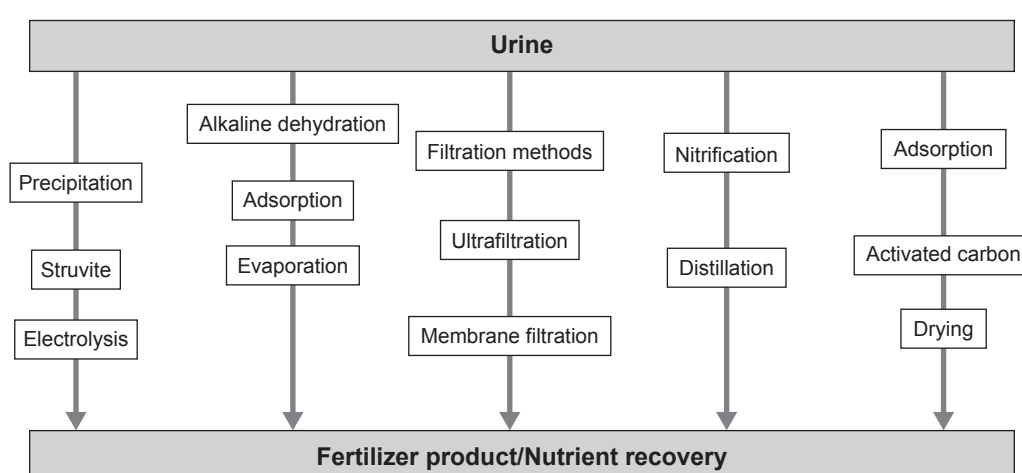


Figure 1. Examples of different methods and technologies under investigation to treat urine for nutrient recovery and fertilizer product development.

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Implementation of Kangpisman Program for Zero Waste in Bandung City

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Keywords: Kangpisman, zero waste, Bandung

Waste is one of the classic problems in Bandung. With approximately waste disposal of 0.65 kg/person/day, the waste disposal of Bandung is estimated around 1,500–1,600 tons/day. The wastes are mixed and mainly disposed to Sarimukti Landfill, the final disposal site around 45 km from Bandung City.

In order to improve the waste management system, the Bandung City Government has launched a new waste management paradigm and concept. The implementation of the 3R, circular economy, zero waste and the application of decentralization of waste management. is endeavored earnestly. Besides, Bandung's new paradigm means that waste is a potential new resource if it is handled properly.

To carry out the new paradigm, the Bandung City Government introduces the Kangpisman Program to the society, which means to reduce, separate, and use for better waste management.

The Kangpisman Program is campaigned massively. To start the new system and to raise public consciousness, Bandung City government constructed the pilot models simultaneously. For this purpose, collaboration with the Regional Office, Local Leaders and RW cleaning operator was established.

At the launch of the Kangpisman Program in early 2019, the Bandung City government built a pilot model of 12 RWs, whereas in 2020 was constructed a village scale model in Sukamiskin and Cihaurgeulis Village. By the end of 2020, Kangpisman Program was introduced and implemented in 147 interested RWs.

In connection with sanitation issues, the separation and handling of organic waste is the important subject, since improper handling garbage of the organic waste causes disgust, dirty, and bad smell. Based on the conditions and interests of the residents, the handling of organic waste is carried out by two approaches where partially in the yard of each house and by communal exertion.

The organic waste was processed and utilized according to the agreement of the residents, such as biopore, Takakura, composter, terawang brick, loseda, as well as black soldier fly maggot.

Figure 3 shows the adherence level of residents on waste separation in Kelurahan Sukamiskin.

By utilizing the waste, as shown in Table 1, it would minimize the residual waste disposal to the temporary Transfer Station (TPS) or final landfill (TPA). Since waste utilization is not fully implemented in Bandung City, there is no exact data yet on waste disposal into the final landfill (TPA). Normally, the generation of waste every year increases with population growth. Figure 4 shows the increase of waste dump into the TPA annually.

Interestingly, in 2019 when the Kangpisman was introduced initially, the waste disposed into the final landfill declined significantly from 8 to 3.9%. The decrease was drastically occurred in 2020 to 0,47%. The data reveals that Kangpisman has positive impact on waste disposal to the landfill (TPA).

The outcome encourages the Government of Bandung City to implement the Kangpisman program on entire Bandung City, which gradually improves the waste management in Indonesia.

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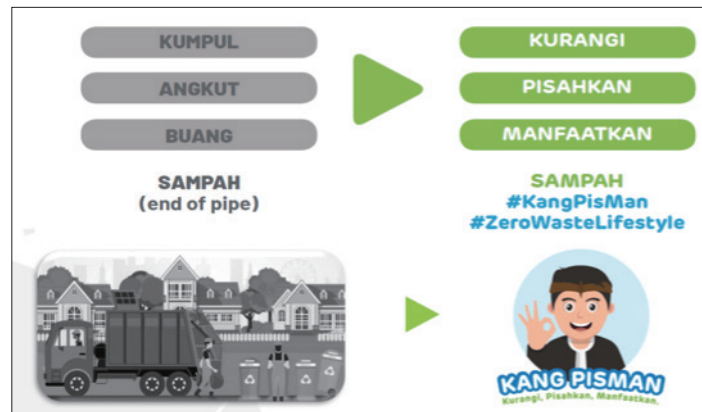


Figure 1. Transformation in the Paradigm of Waste Management through Kangpisman Program. (PD Kebersihan Kota Bandung 2020)

KANG PISMAN
Kurangi ; Pisahkan ; Manfaatkan ;
 Kang Pisman setiap harinya selalu membiasakan:
 Di rumahnya, Kang Pisman membagi tempat sampah menjadi 3 jenis berbeda
 Sampah yang sudah dipisahkan, dimanfaatkan sesuai dengan jenisnya.

- Kurangi :**
 - Mengurangi penggunaan kantong plastik, styrofoam dan bahan lain yang sulit diurai oleh alam.
 - Menggunakan kembali barang-barang yang masih bisa digunakan.
 - Membawa kantong belanja, tempat makan dan minum sendiri ketika berpergian.
 - Makan dan minum secukupnya dan menghabiskannya.
- Pisahkan ;**
 - Jenis 1 :** Sampah sisa makanan & tumbuhan, ditempatkan pada ember tertutup.
 - Jenis 2 :** Kertas, kaleng, gelas & botol plastik, ditempatkan pada kotak kardus.
 - Jenis 3 :** Sampah lainnya ditempatkan pada tong sampah.
- Manfaatkan ;**
 - Sampah jenis 1 diolah kedalam bio pori, komposter, lakakura, bata terawang, biodigester, magot BSF, serta menjadi makanan ternak dan kascing.
 - Sampah jenis 2 dapat dijadikan sedekah sampah ataupun diberikan kepada bank sampah terdekat.
 - Sampah jenis 3 Dibawa ke Tempat Penampungan Sementara (TPS) untuk diangkut ke Tempat Pemrosesan Akhir (TPA) oleh PD Kebersihan.

Mulai gerakan #KangPisMan dengan aksi #BandungPisahkanSampah

Kenapa perlu? #BandungPisahkanSampah

- Sampah jadi jorok, jijik, bau dan sumber penyakit karena tercampur.
- Rumah jadi lebih bersih, nyaman dan lebih bebas penyakit.
- #BandungPisahkanSampah membantu proses pengelolaan sampah Bandung yang lebih maju.

Figure 2. The Kangpisman Campaign. (PD Kebersihan Kota Bandung 2020)

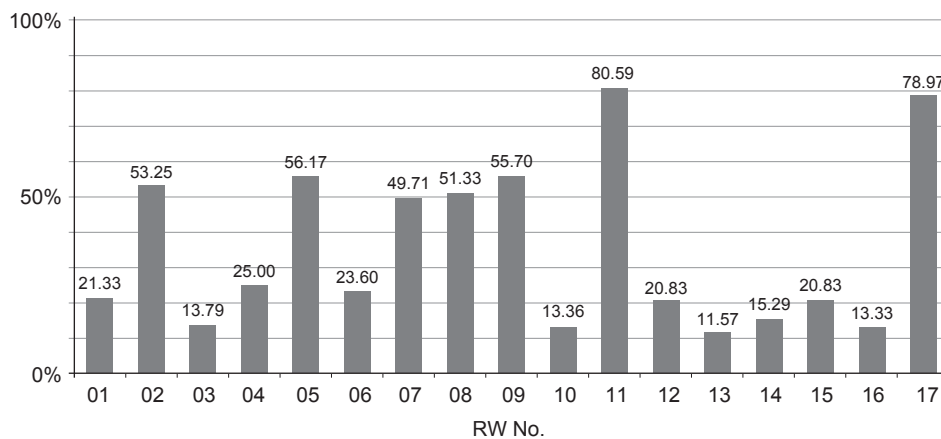


Figure 3. Level of Adherence to Residents' Waste Separation in Kelurahan Sukamiskin. (Adapted from DLHK Kota Bandung 2020)

Table 1. Amount of Organic Waste that is processed and utilized in Kelurahan Sukamiskin.
(Adapted from DLHK Kota Bandung 2020)

Name RW	April	May	June	July	August	September	October	Total (kg)
01 Simpangsari	490.10	980.00	1,671.00	2960.00	3,050.00	3,080.00	3,392.00	15,623.10
02 Banjirsari	0.00	469.40	1,653.40	2447.00	2996.00	1,929.00	2,854.00	12,348.80
03 LP Sukamiskin	0.00	0.00	27.00	11.00	8.00	67.00	94.00	207.00
04 Pesant Ren	0.00	102.18	586.50	772.00	756.00	878.00	996.00	4,090.68
05 Mekar Jaya	168.86	639.00	111.00	2,373.00	2,033.00	2,526.00	3,072.00	10,922.86
06 Neglasari	0.00	0.00	1,210.00	1,537.00	1,363.00	1,804.00	1,680.00	7,594.00
07 Aspol Sukamiskin	0.00	31.00	1,798.50	1,635.00	1,544.00	1,377.00	1,067.00	7,452.50
08 Mekarsari	57.50	53.00	371.50	836.00	538.00	1,118.00	1,289.00	4,263.00
09 Arcamanik Endah	408.00	508.00	482.00	1,468.00	1,107.00	1,098.00	2,102.00	7,173.00
10 Arcamanik Endah	0.00	0.00	0.00	687.00	1393.00	1,150.00	1,230.00	4,460.20
11 Cipagalo	0.00	0.00	536.00	1,211.00	1088.00	931.00	1,645.00	5,411.00
12 Arcamanik Endah	70.66	63.00	219.50	1098.00	674.00	1,030.00	1,050.00	4,205.16
13 Arcamanik Endah	66.75	1,564.20	2,331.06	1,602.00	2,265.00	2,598.00	2,997.00	13,424.01
14 Arcamanik Endah	0.00	0.00	263.50	1,624.00	1,690.00	1,698.50	2,547.00	7,823.00
15 Arcamanik Endah	0.00	52.00	85.00	764.00	683.00	1,113.00	1,147.00	3,844.00
16 Pos Giro	0.00	45.18	78.00	195.00	299.00	417.00	555.00	1,589.18
17 Sarimas	0.00	20.00	244.00	989.00	1,226.00	1,316.00	979.00	4,774.00
Sukamiskin	1,261.87	4,526.96	11,667.96	22,209.00	22,713.00	24,130.70	28,696.00	115,205.49



Figure 4. The tonnage of Bandung City waste disposed of at the Sarimukti Landfill.
(PD Kebersihan Kota Bandung 2020)

Applying an Integrated Framework for Improving Sanitation Uptake and Sustainability in Rural Karangasem, Bali

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Keywords: integrated frameworks, sanitation, rural, determinants, uptake, sustainability

An effective sanitation system is vital for public health and the environment, as poor sanitation is a key contributor to a high burden of diarrhoea and hygiene-related diseases and environmental pollution. Yet 2.4 billion people in developing countries are without access to sanitation facilities. The challenges lie in the complex nature of sanitation issues from uptake to sustainability, which requires a multi-disciplinary solution. This paper applied an analytical tool “Integrated Framework for Sanitation Service” (IFSS) developed in this study to combine health promotion and engineering perspectives in order to examine a complete sanitation system from uptake to sustainability. Using an ecological public health promotion approach, this framework examines the determinants at all levels from the individual level to the structural level. While the engineering perspective of a complete sanitation system considers the needs for accelerating sanitation uptake and also for ensuring the sustainability of a sanitation system. The paper was based on a case study conducted in rural Karangasem, Bali that using a mix method approach by conducting a survey on 200 households and interviews with multilevel stakeholders. Using the IFSS framework, determinants of sanitation uptake and sustainability were identified and comprehensive strategies were developed.

The analysis shows the main issues of sanitation uptake in study areas, which relate to lack of demand, complexity and inadequate construction quality as well as sustainability issues that relate to non-continuous use of the facility, damage to the facilities and lack of safe waste disposal practice (Figure 1). The analysis also illustrates the intertwined determinants across the five ecological categories and across the sanitation value chain (Figure 1).

Uptake of sanitation practice includes the stage of accepting the practice and constructing the facility. At the acceptance stage, the communities in study areas had little demand for a toilet. Lack of demand is a common issue highlighted in sanitation literature which has led sanitation interventions to focus on software aspects of people’s perceptions and needs (e.g., Cole et al. 2012). Those who are motivated to build toilets sometimes face the issue of complexity of toilet considerations that relate to local priorities and values. Local values and customs are frequently stronger in rural areas and create significant issues concerning sanitation practices which are highly embedded in the culture (Akpabio 2012). The construction of toilets in rural areas also has an issue of low quality in terms of proper design and strength to ensure adequate and long-term use and function. Further, sustaining the sanitary practice includes continuous use and maintenance of the facility, and ensures safe disposal or reuse of the waste. At the utilization stage, the built toilets are sometimes not being used throughout the year by all family members. This means that the practice of sanitation is not yet universal and sustained (Potter et al. 2011). In regards to maintenance, a few toilets were found to be damaged due to clogging, natural disaster or cultural reasons. Moreover, currently no plan has been prepared for rural areas in regards to the promotion and provision of maintenance and safe disposal services.

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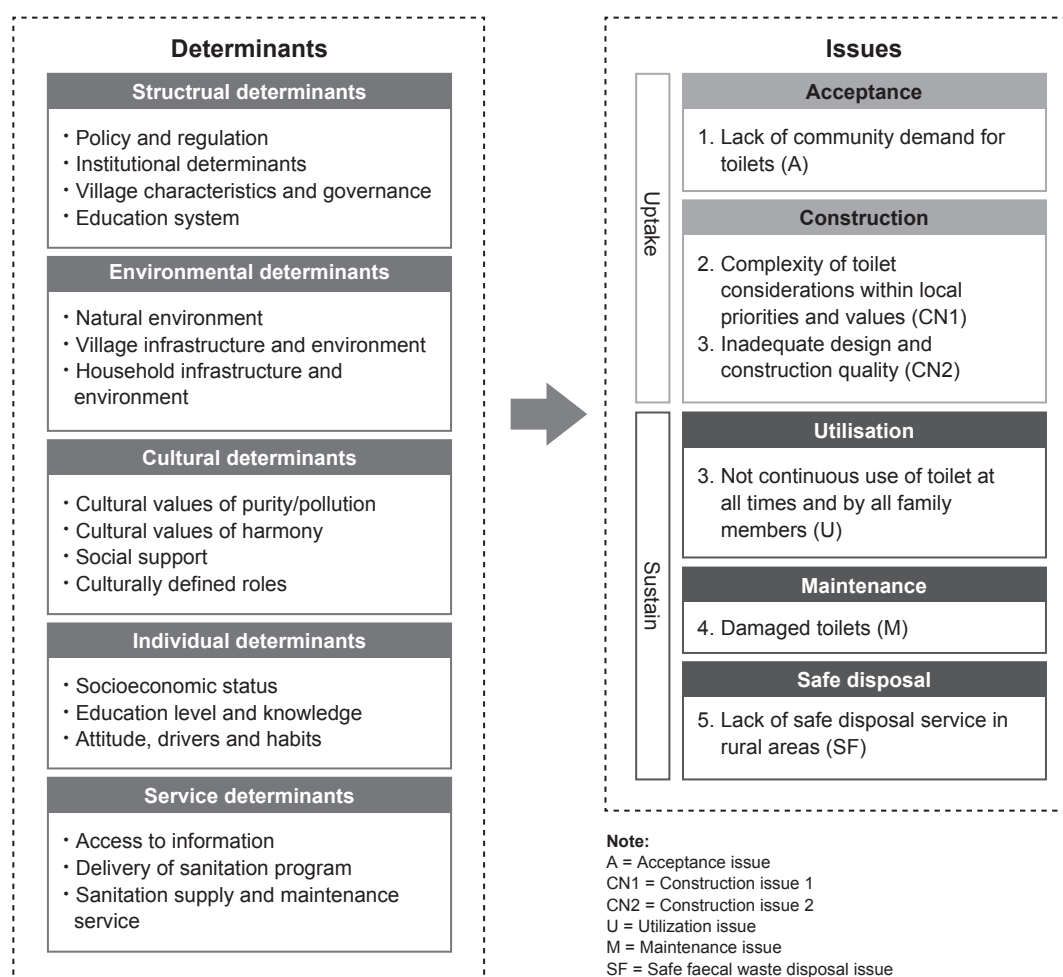


Figure 1. Issues and determinants of sanitation uptake and sustainability in rural Bali, Indonesia.

These interrelated determinants also suggest that sanitation professionals should pay more attention to cultural values and the community structure in addition to the attention to the individual capacities in order to improve the program's effectiveness. The recommended strategies include improving policies and guidelines to facilitate collaboration, working with cultural values and norms, and improving supply and maintenance services to meet local needs.

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Soap Liquid Waste due to Covid-19 Pandemic in Magelang City: Challenges and Recommendations

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Keywords: Covid-19, pandemic, soap, waste, SWOT

The Covid-19 pandemic had a domino effect in various socio-economic aspects of society. The emergence of a pandemic has forced several countries to implement policies to restrict social, economic activity, and mobility of citizens. One of the effects of this policy is the reduction of pollutant loads and the restoration of environmental quality. However, this pandemic has also caused other environmental problems. Covid-19 gave a secondary negative impact, such as reducing recycling and increasing waste. Meanwhile, the potential for water and soil pollution comes from the use of soap in large quantities during the pandemic as washing hands using soap become a new habit in the community. This phenomenon does not only occur on a global and national scale but also reaches the level of the smallest administrative area. Magelang City is one of the regions that is starting to feel the impact of a significant increase in soap liquid waste. With the prediction that this pandemic will not end in the near future, and washing hands using soap will then become a new habit in the community, measuring the potential for liquid soap waste becomes an important thing as a reference for mitigating the risk of water and soil pollution in the long term.

This study uses descriptive analysis to measure the potential for soap liquid waste enhancement in Magelang City. Secondary supporting data is obtained from the official publication of WHO, Environmental Department of Magelang City, and the Central Statistics Agency of Magelang City. This study also presents a SWOT analysis used to map and formulate soap waste management policies in Magelang City in a sustainable manner. Details of the research variables are presented as follow (Table 1):

Table 1. Research Variables and Definitions.

No	Variables	Definitions
1	Frequency (F)	The frequency of washing hands per day using soap
2	Quantity (Q)	Average use of sink water for washing hands
3	Coefficient (c)	Waste generation coefficient
4	Population (P)	Number of populations over 5 years of age in Magelang City

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The production of liquid soap waste was obtained from the product of the waste generation coefficient, the average use of water for washing hands, and the frequency of washing hands per day. While, the data for the population variable in this study used the population of Magelang City over five years of age. This is based on data from the Covid-19 Task Force, that a confirmed case of Covid-19 has been found in this age group. Therefore this age group also plays an important role in implementing the health protocols. The calculation of the potential volume of soap liquid waste is proxied from the output function as formulated in equation:

$$\text{Volume of Generated Waste (V)} = c \times Q \times F \times P$$

Results showed that the appeal to wash hands using soap is massively implemented in all sectors with the hope that the protocol will become a new normal habit in the daily life of the people of Magelang City. The application of this new habit will certainly provides an unavoidable potential for soap liquid waste. Therefore, mitigation against the risk of accumulating soap liquid waste needs to be formulated in a comprehensive policy. This study showed that there was an increase in the volume of soap liquid waste in Magelang City at normal condition and during pandemic by the average of 50.71 percent. Laboratory examinations of grey water samples containing handwashing waste were taken from one of the offices in Magelang City and showed that several parameters exceed the established quality standards. Although several technological innovations to reduce soap liquid waste in Magelang City have been initiated, however, the utilization needs to be expanded so that the reduction of soap liquid waste becomes more effective and significant.

Application of Upflow Anaerobic Sludge Blanket (UASB) Reactor Technology for Wastewater Treatment: Technical, Environmental and Socio-Economic Assessment in Developing Countries

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Keywords: developing countries, sustainability, UASB reactor, wastewater treatment systems

Wastewater management is one of the major challenges faced by most developing countries in Sub-Sahara Africa. Population growth and urbanization have led to the generation of large volumes of wastewater, which are discharged into the environment without treatment due to inadequate infrastructure. Wastewater contains contaminants and pathogens that are harmful to public health and the receiving ecosystems. Wastewater is however rich in organic matter and nutrients which can be harnessed into useful resources. Conventional wastewater treatment technologies implemented in high-income countries are usually not suitable for low-income countries due to high installation and operational costs. Thus the need for an efficient and economically feasible wastewater treatment technology in developing countries cannot be overlooked. The Upflow Anaerobic Sludge Blanket (UASB) reactor technology which requires low energy consumption, produces less sludge and generates biogas as bi-product may be an appropriate alternative for developing countries.

Sustainable wastewater management is one that does not only focus on eliminating water pollution but also seeks to minimize environmental burdens and potential impacts from wastewater treatment systems, preserve human health and recover nutrients from wastewater. As the global community shifts towards attaining sustainability, several research works have been carried out to assess the sustainability of wastewater treatment systems in developed countries, these studies consequently lacking in the context of developing countries. This case-study based research is thus intended to evaluate the sustainability of the Mudor Wastewater Treatment Plant (MWWTP) located in Accra, the capital city of Ghana. The MWWTP employs the UASB reactor technology with post-treatment units to treat municipal wastewater generated in various suburbs of Accra.

The first objective of this study is to assess the performance of the treatment plant by determining the pollutant removal efficiency of parameters of interest. Secondly, the life cycle analysis (LCA) technique will be employed to evaluate the environmental burdens and potential impacts associated with the various unit processes during operations of MWWTP. Finally a socio-economic assessment will be conducted. The cost-benefit analysis approach will be employed to determine the total cost of running the plant (Capital and Operational Expenditure). The corresponding benefits from bi-products such as biogas and sludge with energy recovery potentials, sludge as fertilizer and nutrient-rich reclaimed water for irrigation practices will also be evaluated. The socio-cultural implications regarding public perception and acceptance of wastewater sludge for agricultural purposes, irrigation with treated wastewater and consumption of food crops cultivated with this waste stream will also be assessed. Methodology for the study objectives has been conceptualised in the chart below (Figure 1):

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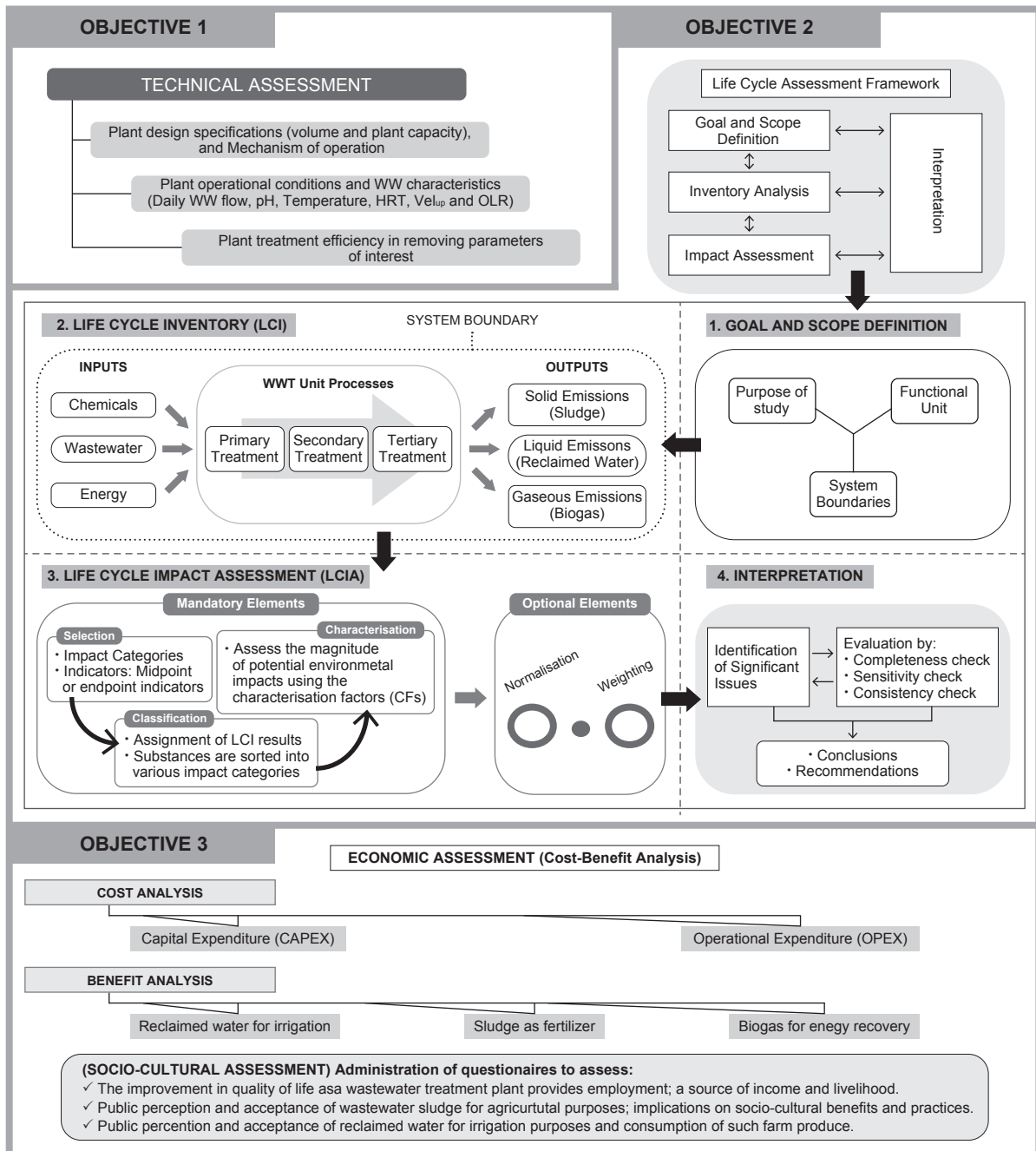


Figure 1. Research Methodology.

From the study, the following results will be expected to be achieved:

- Establishment of the performance and pollutant removal efficiency of the municipal-scale UASB reactor coupled with the post-treatment by Trickling Filter.
- Identification of environmental hot spots in the Mudor WWTP system operations with significant environmental burdens that requires consideration for improvement.
- Establishment of the socio-economic impacts of the Mudor WWTP.

Used of Black Shale Adsorbent for the Removal of Sodium Adsorption Ratio (SAR) from Greywater

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Keywords: black shale, greywater, optimal dose, salinity, SAR removal

The water crisis is an upcoming phenomenon that threatens countries all over the world. Indeed, various parts of the world are suffering from a shortage of water resources. In this context, the reuse of wastewater is an alternative solution for agriculture. Greywater reuse is one of the main options for reducing potable water consumption in agriculture. In fact, greywater originates mainly from laundry, bathing and kitchen activities carried out at household level. Greywater reuse helped community members gain valuable gardening, irrigation, and food preservation skills. The nutrients (i.e., nitrogen (N), phosphorus (P) and potassium (K)) present in greywater effluent most beneficial to plants and soil fertility irrigated. Despite many advantages of greywaters, they could represent a potential risk to the environment, particularly on soil irrigated. Indeed, the high Sodium Adsorption Ratio (SAR) in an untreated greywater may cause long-term effects of salinity, low water infiltration rates and water clogging in irrigated soil. In this context, the study was carried out to reduce SAR value from untreated greywater by the geo-materials like black shale. The specific objectives are (i) to determine optimal dose, and (ii) to study the effect of pH and contact time on Na⁺ removal (SAR reduction). Batch experiments were performed by adding the sorbent in bottles and raw greywater (500 mL). The detrimental effects of sodium salinity and sodicity are determined based on the proportion of sodium (Na⁺), calcium (Ca²⁺) and magnesium (Mg²⁺) in greywater or the values of Sodium Adsorption Ratio (SAR). The shale used in this research is local natural material collected at Lomo Nord, in Ivory Coast Center. Samples were crushed and sieved to have desired particles size (less than 80 µm) using a Saulas NF.X 11.501 sieve.

A batch test was performed to determine the best sorbent concentration. During the batch tests, the concentration of sodium was periodically tested because of the importance of this parameter for plant physiology (Matos et al. 2010) and its contribution to the salinity of irrigated soils (Sangare et al. 2018). To determine the optimal dose of sorbent, a wide range of adsorbent masses (0.0 ; 0.8 ; 1 ; 2 ; 3 ; 4 ; 5 ; 6 ; 7 ; 8 g) were shaken in 50 mL of an sodium solution (385.7 mg/L). The Na⁺ adsorbed percentage was calculated using this relation (1):

$$\% \text{ Na adsorbed} = \frac{(C_0 - C_t)}{C_0} \times 100 \quad (1)$$

The amount of Na⁺ adsorption at equilibrium, q_t (mg/g), was calculated by using following equation (2):

$$q_t = \frac{(C_0 - C_t) V}{m} \quad (2)$$

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where: C_0 (mg/L) = initial Na^+ concentrations, C_t (mg/L) = equilibrium Na^+ concentrations, V (L) = volume of the greywater solutions, m (g) = adsorbent mass, q_t (mg/g) = adsorption capacity at equilibrium.

On the other hand, the effect of solution pH was carried out by adding the optimal dose of sorbent in 50 mL of untreated greywater at 385.7 mg/L as the initial concentration at different pH values (2.0–10.0). These pH values were obtained by adding into each solution the required amounts of dilute nitric acid (HNO_3) or sodium hydroxide (NaOH). The mixture was agitated with a rotary shaker (Retsch, Germany) for 12 hours at 25°C. The Na^+ adsorbed percentage was calculated according to equation (1).

Besides, Sodium Adsorption Ratio (SAR) was evaluated according to equation (3):

$$\text{SAR} = \frac{[\text{Na}]}{\sqrt{\frac{[\text{Ca}] + [\text{Mg}]}{2}}} \quad (3)$$

where: Na^+ , Ca^{2+} and Mg^{2+} were expressed in meq/L.

The results showed that Na^+ removal efficiency increased adsorbent dose increase. The rate of Na^+ adsorption is in parallel with SAR value in untreated greywater. The optimum percentage was 30% for an optimal concentration of 60 g/L Shale. And the other hand, the Na^+ adsorption capacity increased from 0.073 mg/g to 0.168 mg/g shale and decreased thereafter. Maximum Na^+ adsorption was observed after a stirring time of six hours for black shale.

One could observe that efficiencies of the sorbent to remove sodium increased parallel to pH and attained a maximum at pH 6–8 for shale.

The present study demonstrated that the use of geo-materials like black shale proved to be a cheaper method of removal Na^+ (SAR reduction) from untreated greywater and its applications may offer an alternative to the problems of wastewater treatment in areas where modern systems are either unavailable or too cost ineffective.

The Impact of COVID-19 Prevention Measures on Water Quality: An Indonesian Perspective

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Keywords: COVID-19, hand hygiene, hand washing, water quality, wastewater

COVID-19 (coronavirus disease 2019), caused by the SARS-CoV-2 virus, has infected many countries worldwide, including Indonesia and has been declared a pandemic. To prevent the spread of the disease, several measures are implemented, most notably physical distancing, wearing masks, and hand hygiene. These measures have shown their efficacy in preventing the disease. On the other hand, several impacts of these measures, both positive and negative, also prevail.

Physical distancing is the act of maintaining a recommended distance (guide varies between 1–2 m) in contact with other people. In some countries, physical distancing is enforced by lockdown and travel restrictions. The closure of industrial activities during lockdown has reduced pollution load, significantly improves river water quality in several developing countries. A preliminary study reported a decrease in the amount of chlorophyll-a in several water bodies in Jakarta during a period of large-scale social distancing (Adwibowo 2020). Chlorophyll-a is an indicator of phytoplankton in waters, whose presence is closely related to water quality and abundance of nitrogen and phosphorus compounds.

The use of masks has been shown to reduce SARS-CoV-2 spread from droplets significantly. However, the sheer volume of used masks creates disposal problems. There are reports of used masks littering public places and enter rivers and oceans. Aside from the aesthetic, mask litters potentially increase microplastic problems in the aquatic environment (Fadare and Okoffo 2020).

Hand hygiene is implemented via handwashing with soap and the use of hand sanitizer. There are challenges in implementing the former in Indonesia, most notably the availability of clean water and familiarization with handwashing habits (Purnama and Susanna 2020). The increased handwashing practice consequently increases the need for clean water and add pressure in regions where water is scarce. In addition, it also increases the generation of domestic wastewater (greywater). Unlike industrial wastewater which is more regulated, domestic wastewater treatment is loosely implemented. Only several cities have centralized wastewater treatment plants, e.g. Jakarta, Bandung, and Surabaya. Even when treated, domestic wastewater contains organic compounds that may be persistent, including drugs, hormones, and compounds derived from sanitary and personal care products such as fragrances, stabilizers, biocides, etc. It becomes worse when some personal care products possible to bind on plastic particle in aquatic environment (Wilkinson et al. 2017). These can affect aquatic organisms directly, or through bioaccumulation, therefore, an increased amount of domestic wastewater is of concern.

To measure the impact of COVID-19 prevention measures on water quality, an analysis of water and material balances is required. The impact of reduced industrial activities would be countered by additional “new” pollutant sources from increased handwashing practices (Sivakumar 2020). Pollutant concentration in domestic wastewater

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would be determined by water volume, product volume, and product type. The impact depends not only on the extent of measures but also on policies in place (Awoke et al. 2016). When regulations of industrial wastewater treatment and discharge are strictly implemented, the impact of increased domestic wastewater volume and persistent organic pollutants may outweigh the lower pollutant load from industries.

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Physical and Mental Health of Sanitation Workers in an Urban Slum of Indonesia: Personal Hygiene and the Construction of Self-Esteem in Waste-Handling

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Keywords: dirty work, personal hygiene, urban slum, self-esteem, solid waste management

Background: Garbage workers, that is, sanitation workers, play a significant part in existing sanitation systems. In developing countries like Indonesia that are faced with a massive challenge in waste management due to the lack of sophisticated sanitation infrastructure, garbage workers engage in informal waste management, specifically, waste collection, segregation, and recycling at the expense of their safety, health, and self-esteem. On reaching the dumpsite, unsegregated waste predisposes these workers to a range of health risks caused by improper manual waste-handling without protective gear. At the same time, many studies have argued that garbage workers face social denigration and marginalization because of the nature of their work that requires daily contact with dirt, subsequently making the society to view them as “dirty workers”. This study aimed to examine physical and mental health of garbage workers in terms of (1) sanitation issues at their workplace, (2) waste-handling and personal hygiene, and (3) the construction of self-esteem.

Method: Based on the purpose above, this study was conducted with a sample of 7 garbage workers in an urban slum of Bandung in West Java Province, Indonesia through actual participation in garbage segregation and semi-structured interview. The former was aimed at exploring how garbage workers handle a range of wastes and behave towards waste characteristics (e.g., wetness, odor, dirt), whereas the latter was for examining (1) the extent to which they feel annoyed by aforementioned sanitation issues, (2) self-consciousness of being viewed and evaluated by the society about their job, and (3) views towards their job (e.g., motives).

Results and Discussion: Results indicated certain waste issues affecting garbage workers, representing wetness (i.e., menstrual products and animal corpses) and hazardous waste (i.e., medical syringes, broken glasses, and skewers). However, the study confirmed that workers handled the aforementioned waste with no proper safety gear (e.g., gloves, boots and long pants) due to physical discomfort experienced from its use. Safety gear caused itchiness, body heating and work inefficiency, which contributed to actual injuries and food intake without handwashing by some workers. Although participants stated being well aware of exposure to potential health risks and their ability to avoid them by consciously handling waste with care, their familiarity with waste handling could lead to poor personal hygiene and subsequently expose workers to wide-ranging health risks.

Denials of self-esteem were reported by some workers, reporting no appreciation and undervaluation of their job from others. In this sense, preparedness of physical dirt and potential health risks may further erode workers' self-

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esteem as it displays tolerance of a distasteful work environment leading to disparaging attitudes towards their job and themselves from the society. At the same time, however, tolerance of physically demanding and exhausting work may also be seen as traditional masculinity. Our study also revealed a reframing from occupational ideologies, in particular the social significance of their job in the residential areas. Furthermore, workers reported self-reliance attained through financial stability for their family, and freedom at work credited to flexible working hours and no supervisions from the superior. These elements reported are seen as social comparisons and refocusing. Thus, garbage workers may neutralize or transform the stigmatized aspects of their job by reframing, refocusing and social comparisons with others.

Conclusion: Taken together, the overall findings suggest that physical health of garbage workers may be compromised due to their improper personal hygiene but certain techniques of occupational ideologies and social comparisons may allow them to maintain/construct positive identity by imbuing positive values.



Figure 1. Waste-handling at dumpsite.

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Hazard Analysis and Critical Control Point (HACCP) of Food Stall on Campus in Yogyakarta, Indonesia

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Keywords: food stall, campus, HACCP, Indonesia, Yogyakarta

The implementation of Hazard Analysis and Critical Control Point, named HACCP, in Indonesia is still focus on food manufacturing, hotel, restaurant, and hospital. The cost of HACCP certification standardized by The Ministry of Industry in Indonesia is relatively high (Ministry of Industry 2019). However, HACCP is pivotal method to control potential hazard in food services. Other food services, such as small restaurant, food stalls, and so on also require giving more attentions.

Indonesia is one of developing countries in South-east Asia possesses high food poisoning cases, and most of them caused by foodborne disease. As Lambrechts (2014) reported, about 97% of food borne disease is generated by lack of personal hygiene. Yogyakarta, special region in Indonesia, is notable as student city, where thousands students live in. Those students prefer to buy food from food stall around campus area, and price and taste of food stall is more important than food hygiene condition for them. According to Public Health of Yogyakarta, Yogyakarta was in the third rank of highest poisoning cases in Indonesia. Moreover, only 40% restaurants including food stall were categorized healthy in Yogyakarta (Cahyaningsih 2009). This study aims to investigate reality of hygiene condition in those food stalls around campus in Yogyakarta, by applying HACCP and its principles.

Thirty three food stalls are randomly sampled from about 72 food stalls located in one of the biggest private universities in Indonesia. Subsequently, pathogen bacteria, such as Coliform, was analysed by Chromocult Coliform Agar. Each food stall was investigated by the observation sheet referred to Minister Health Decree of Indonesia, i.e. Kepmenkes Number 1098/2003. Furtherore, in-depth interviews were conducted to the owner and food handlers. Qualitative analysis was applied to describe the implementation of HACCP on food stall.

Based on the observed results, the critical points are identified in 8 steps of food stall services (Table 1). Each step is potential to own biological, chemical, and physical hazards that it is solved by taking appropriate actions, such as showing in Table 1. The potential hazards are correspondent to hygiene condition, both environment and personal hygiene. In Figure 1, data explain particularly good enough about 60–70% comprising of food sanitation, facilitate sanitation, personal protection equipment and personal hygiene, except hygiene training.

About 56.05% food handlers are lack of hygiene knowledge, behaviour, and attitude, for example the awareness to wash their hand using soap before handle or cook the food, careless to wearing apron, mask, head cover, and so on. In addition, all of examined food stalls do not have a lavatory for washing hand, especially for the costumers and not have equipment for repelling insect and rodents. Three out of 33 food stalls are estimated to present *E. coli*.

HACCP implementation of food stall in campus has not yet effective due to lack of knowledge about HACCP principles. Hence, in verification data, environmental sanitation including food and facility sanitation, also personal hygiene is contribute to become a pivotal factor in HACPP implementation.

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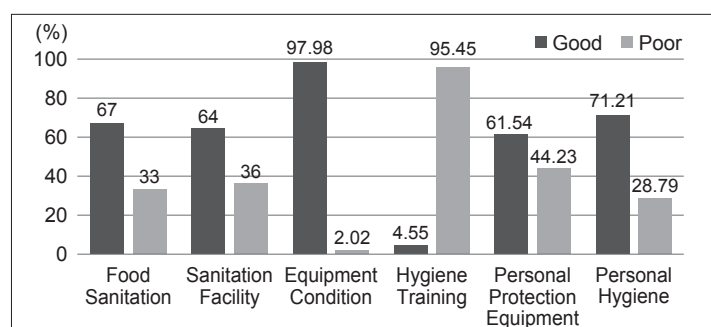


Figure.1 Sanitation hygiene.

Table 1. Hygiene condition of food stall based on HACCP principles analysis.

Critical Control Points	Hazard Analysis		Hygiene Contribution	Monitoring	Correctives Actions
	Hazard	Critical Limits			
Supplying of raw materials	Biology	<i>Salmonella, E.Coli, Staphylococci, Bacillus Cereus, Clostridium sp</i>	Environmental hygiene	Screening process to pick up the raw materials	Washing the raw material with antibacterial-soap
	Chemical	Pesticides, preservatives or bleaches			Sorting between good and poor raw material
	Physical	Sand, fur/hair, dirt, dust			Using clean and closed box
Storage of raw materials	Biology	<i>E.Coli, S.Aureus, total coliform, insects, rat</i>	Storage hygiene	Splitting container based on the difference raw materials	- Using clean and closed box - Using refrigerator (low temperature)
	Physical	Humidity, temperature			Sorting between good and poor raw material
Cutting process	Biology	<i>Staphylococcus aureus, E.Coli, total coliform</i>	Personal hygiene	Using clean equipment	Using clean (sterile) equipment
	Physical	Dust, fur/hair, dirt			applying personal protection equipment
Washing Process	Biology	<i>E.Coli, total coliform</i>	Personal hygiene	Using clean water and equipment	Using clean (sterile) equipment and water
	Chemical	Heavy metal, pesticide			applying personal protection equipment
Cooking Process	Biology	<i>Staphylococcus aureus, E.Coli, total coliform</i>	Environmental hygiene	Using clean equipment and applying personal protection equipment	Using clean (sterile) hand and equipment
	Chemical	MSG			Following the receipt
	Physical	Dust, fur/hair, dirt, temperature			applying personal protection equipment
Storage of cooked food	Biology	<i>E.Coli, total coliform, insects, rat</i>	Environmental hygiene	Splitting closed-container based on the difference food	Using clean (sterile) box
	Physical	Humidity, temperature			Paying attention to temperature and humidity
Food Serving	Physical	Dust, fur/hair, dirt	Environmental hygiene	Using food covering	applying personal protection equipment and food covering
Re-heating food	Biology	<i>Staphylococcus aureus, insects</i>	Personal hygiene	Cooking based on order	Using high temperature
	Physical	Temperature			

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Identification of Key Zero Waste Management Indicators for West Java

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Keywords: solid waste, zero waste management indicators, West Java

As the most populated province in Indonesia, West Java is facing serious problems in managing the increasing solid waste volume, especially those generated from urban areas. Many studies showed that, under current waste management practices (collect-transport-disposal, or CTD approach), the solid waste generation will almost exceed the capacity of landfill sites within the next decade. Thus, relying on the application of CTD will not be sustainable for the future of waste management in West Java.

Since the past decade, 'zero waste' concept has been emerging as an alternative and innovative approach to address the challenges of solid waste management (SWM). Many studies have attempted different ways to conceptualize zero waste principles to be applied in different contexts. The basic notion of zero waste is to consider and recognize waste as a resource, and encourage the redesign of its life cycle so that all materials can be reused. The ultimate goal is for no waste to be dumped into landfill and other mediums.

In Indonesia, the application of zero waste principle was first introduced in the SWM Law in 2008 and then further elaborated into a Presidential Decree in 2017, in which all provincial and local governments are mandated to reduce the waste volume by 30% in 2025. However, many local authorities are struggling to measure the performance and progress in waste reduction efforts, en route to zero waste. Therefore, it is urgent to develop appropriate performance indicators that can be measured in a simple manner, easily interpreted, while also accessible and reliable for monitoring waste reduction.

Research conducted in many places have produced different sets of indicators on SWM systems. However, they are yet to be adequately identified and consolidated as key indicators for evaluating waste management system, especially in the context of achieving zero waste goals.

This study is conducted to identify key zero waste indicators, which can then be proposed as a tool to evaluate the performance of West Java zero waste management systems. Upon an intensive literature review, we found 194 zero waste indicators. These indicators were then broadly classified into five different categories such as technical/waste management process, economic, socio-cultural, institutional, and legal/policy aspect. There were 58 of the most frequently appeared indicators from those categories were presented in the online survey. Those indicators were then rated by SWM stakeholders, through various channels, targeting SWM experts/practitioners coming from different institutions. As many as 38 respondents participated in the survey. Table 1 shows the background information of the participants.

The participants then rated the 58 indicators from 'not needed' to 'very high priority'. A number of indicators rated as 'very high priority' by at least 67% of the participants (Chang et al 2009) will be identified as the potential key indicators for the assessment of West Java zero waste management. Following the criteria aforementioned, this study found that 21 indicators from the five categories were identified as the key indicator presented in Table 2.

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The result of this study will provide an invaluable input for the local decision makers to improve the performance measurement of their zero waste management and overall SWM.

Table 1. Background of survey participants.

Affiliation (Top 3)		Years of experience in SWM (Top 3)	
1. NGO/community group	34.2% (13)	1. 1–5 years	55.3% (21)
2. Government (municipality)	21.1% (8)	2. 6–10 years	21.1% (8)
3. Universities/academics	15.8% (6)	3. 11–15 years	13.2% (5)

Table 2. Key indicators for the evaluation of West Java zero waste management.

Aspects	Key Indicators
Technical	(1) reduction of waste going into landfills; (2) waste reduction at source; (3) recycling rate; (4) capacity (service life) of landfills; (5) reduction of negative environmental impacts
Economic	(6) the cost of waste treatment; (7) the cost of environmental impact due to improper SWM; (8) and % of local government budget allocated for SWM
Socio-cultural	(9) Inclusion of SWM in school curricula
Institutional	(10) a system to evaluate waste reduction performance; (11) inter-municipality cooperation in SWM; (12) stakeholders coordination forum; (13) integrated SWM information system; and (14) a system to evaluate the performance of waste handling
Legal/policy (local context)	(15) SWM regulation; (16) specific regulation on waste reduction; (17) policy commitment to achieve zero waste; (18) regulation on Extended Producers' Responsibility; (19) SWM policy and strategy; (20) SWM technical guidelines; and (21) SWM master plan.

Socio-Demographic and Sanitation Factors Associated with Diarrhea Prevalence in Peri-Urban Lusaka, Zambia

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Keywords: sanitation, toilet, peri-urban, diarrhea prevalence, Zambia

Background: In Zambia, Sub-Saharan Africa, poor WASH accounts for 11.4% of all deaths; diarrheal disease outbreaks often originate from peri-urban settlements. Unfortunately, peri-urban sanitation poses a unique challenge due to the peri-urbans high density, unplanned stature, limited space, and limited funding for sanitation installment. Preliminary research in peri-urban Lusaka, Zambia uncovered a common co-use of chambers (i.e., disposable makeshift toilets) even when households owned toilets. Thus, with an aim to understand resident's needs, and inform peri-urban sanitation and public health policy, our study examined the socio-demographic and sanitation factors associated with diarrhea prevalence in peri-urban Lusaka, Zambia.

Methodology: Our study used multivariate stepwise logistic regression to assess the sociodemographic factors associated with diarrhea prevalence and use of three types of sanitation facilities (Figure 1), namely; improved toilets, unimproved toilets and chambers among peri-urban residents. Participants were 205 household heads and their WASH facilities in one peri-urban settlement of Lusaka. WASH facilities were assessed to determine their service level according to the UNICEF and WHO 2017 Joint Monitoring Programme sanitation ladder.

Results: Interestingly, both improved toilets and use of chambers indicated increased odds for diarrhea prevalence. Higher diarrhea prevalence was also found for toilets with more users. Chamber usage was found to be higher among female participants and users of unimproved toilet facilities. Moreover, when toilets were owned by residents, and hygiene was managed by an external party, e.g., landlord, odds of chamber use increased. Lastly, a significant association was found between having an improved toilet facility, access to improved drinking water and basic handwashing, highlighting the dynamics linking WASH access.

Discussion: Results highlight the nature of the current WHO/UNICEF sanitation ladder, and some integral gaps when placed within the peri-urban setting. The inability of outdoor toilets to fully offer privacy and safety to women and girls, and the lack of space for construction of one toilet per household in peri-urban settings were some of these concerns, limiting access and leading to use of chambers even when toilet facilities were present. Additional discussion noted the absence of a safely managed bracket for shared toilets on the sanitation ladder. These findings exposed a lack in user inclusion and toilet hygiene education which are needed for improved toilets to efficiently reduce fecal-oral contamination. This brought to foresight the toilets capacity as a contamination point by way of being an excretion and fecal disposal location, supporting the conclusion that without proper toilet hygiene practices, an improved toilet could increase fecal-oral contact, particularly in high density areas with many users. It also pointed out the need to formally highlight these high density area differences to swing governments and policy makers towards solutions tailored to addressing their unique challenges.

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Conclusion: To decrease pathogen transmission and improve peri-urban health outcomes, our study recommended a separate sanitation ladder for high density areas (Table 1) which considers improved private and shared facilities, toilet management and all-inclusive usage, cancelling the need for unimproved alternatives. It further called for financial plans supporting urban poor access to basic sanitation and increased education on toilet facility models, hygiene, management and risk to help with choice and proper facility use to maximize toilet use benefit.

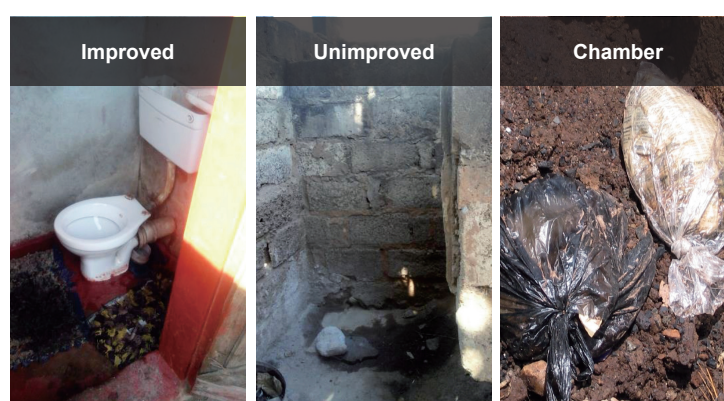


Figure 1. Sanitation types: Improved toilet, unimproved toilet, and chamber.

Table 1. Recommended high density sanitation ladder.

High Density Service Level	Definition
Safely Managed	Use of improved private or shared facilities, usable by all toilet users, at all times (no co-use of unimproved sanitation) with an available responsibility plan or rota and where excreta are safely disposed of in situ or transported and treated offsite
Basic	Use of improved private or shared facilities, usable by all toilet users, at all times (no co-use of unimproved sanitation) with an available responsibility plan or rota
Limited	Use of improved private or shared facilities
Unimproved (No Change)	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines [Chambers come here]
Open Defecation (No Change)	Disposal of human faeces in fields, forests, bushes. Open bodies or water, beaches or other open spaces, or with solid waste [Depending on disposal, chambers come here]

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Determine the Benefits of Changes in Community Attitudes and Their Participation in the Community-Based Water Supply and Sanitation Program (PAMSIMAS) in Landak Regency, Indonesia

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Keywords: attitude, participation, PAMSIMAS

The provision of water supply and sanitation is still a problem. The government has made efforts to create a clean and healthy environment by developing easy and sustainable access to drinking water and sanitation. The community was active in this development program in building indoor wells, implementing clean and healthy behaviour, and establishing a committee to maintain and manage the facilities as an integrated program sustainable towards universal access. The central government, represented by the Minister for Public Works and Human Settlements Republic Indonesia, has run the Community-Based Water Supply and Sanitation (PAMSIMAS) program. This study aims to determine the benefits of implementing the PAMSIMAS program in Landak Regency.

The method used is a quantitative method with data collection techniques through questionnaires to all PAMSIMAS communities in the village, as many as 125 respondents. Besides, this research was conducted using a qualitative approach. The content analysis was done through in-depth interviews, documentary review, and observation. The subjects of this study were regency work unit, partnership committee, district coordinator (DC), co-DC, data entry and administration officer, community facilitator, community self-help group, implementing unit, drinking water facility management group, village government, the village head, sanitarian, and the water using community in a village, Landak Regency (total 35 people). The data were collected by questionnaires.

The results showed that the process of planning, implementing, and maintaining the PAMSIMAS program in Landak Regency were carried out by the community through deliberations. Besides, there had been a change in community behaviour. The effect is in the form of increasing community participation, improving public health figures and managing the program in an organized manner. The community's awareness of healthy and clean living and their participation level in overseeing the program at all the stages can be seen from the maintenance of the PAMSIMAS III program since it was launched in 2017. Therefore, it can be concluded that the PAMSIMAS program has a positive impact on the community: the community can easily access clean water at Rp.10.000/m³ and stop doing open defecation. Changes in the community behaviour and attitudes and their participation level as a form of their sense of belonging to the facilities built in Landak Regency have occurred.

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Table 1. Sample of table.

Variable	f	%
Worker		
Work-female (person)	55	44.0
Work-male (person)	70	56.0
Subject study		
DC	1	0.8
CO-DC	1	0.8
FM-CD	13	10.4
FM-WSS	5	4.0
Community self-help Group	15	12.0
Implementing Unit	45	36.0
KPSPAMS	45	36.0
Changes in Community Attitudes Towards the PAMSIMAS Program		
Very good	72	68.6
Good	25	23.8
Fair	6	5.7
Poor	2	1.9
Level of Community Participation in the Implementation of the PAMSIMAS		
Very high	65	61.9
High	32	30.5
Somewhat high	4	3.8
Low	3	2.9
Very low	1	0.9

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Twinning Programme: Learning from Horizontal Learning on Domestic Wastewater Treatment in Three Districts in South Sulawesi

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Keywords: faecal sludge management, safely managed sanitation, horizontal learning

Indonesia is committed to achieve Sustainable Development Goals, including target on safe and sustainable sanitation. More than 97% districts in Indonesia rely on the off-site sanitation system, which needs chain-service from the septic-tanks to the domestic waste-water treatment (DWWTP). In South Sulawesi, only seven out of 24 cities/districts already have DWWTP, which were built with big investment from the national budget. However, there are lack of management capacity to operate them by city/districts after the facilities were handed over.

Twinning programme is an information exchange programme through horizontal learning, initially developed by Indonesia’s Wastewater Operator Association (Forkalim) on off-site and on-site DWWT, by exercising mentor-mentee schematic in defined and agreed timeframe (Figure 1). The specific objective is to accelerate the dissemination of knowledge and technology on domestic wastewater treatment.

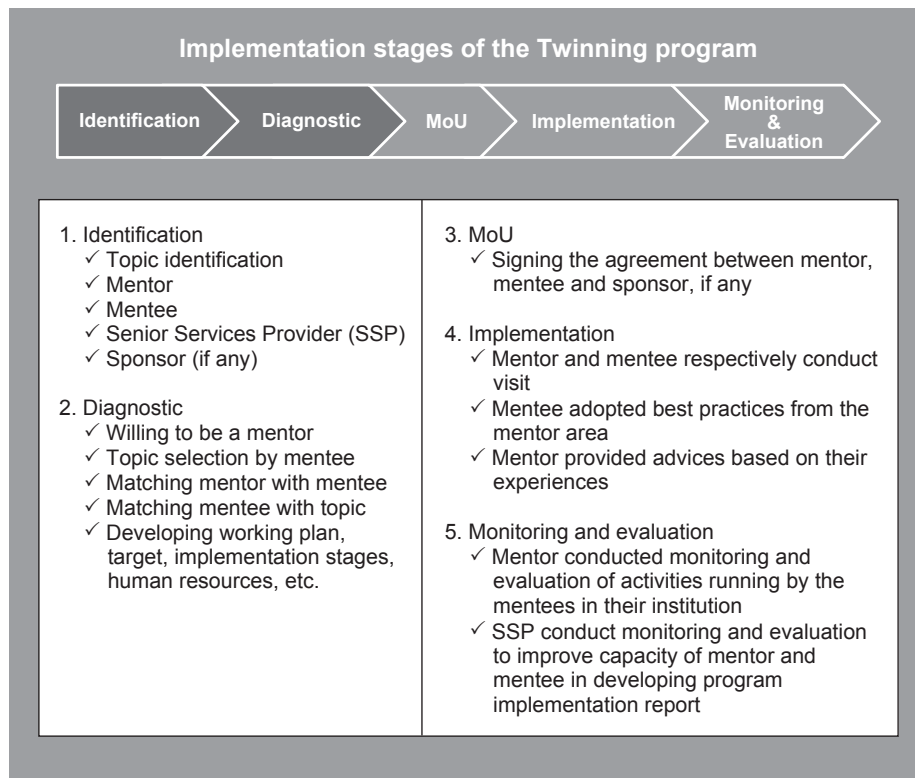


Figure 1. Implementation Stages of Twinning Programme.

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Table 1. Arrangement of Mentor and Mentee.

Topic	Mentee	Mentor
Design and operational of conventional DWWT Plant	Parepare city Pinrang district	UPTD Sidoarjo district
Institutional strengthening of new DWWT Plant management	Palopo city	UPTD Gresik district

Three districts from South Sulawesi, Palopo, Parepare, and Pinrang were selected and paired with their respective mentors from Gresik and Sidoarjo in East Java (Table 1), and exercising learning visits, developing actions plans, implementing them, and evaluating them in an assisted process. Three or four round of learning visits were planned to mentor districts and mentee districts respectively, with follow-up action plans to be developed in between, in the course of 6–8 months. Assurances and supports were provided to the mentees to ensure substantial improvements in short and mid-terms.

The mentee districts were experiencing comprehensive improvement throughout the process, with institutional, technical, and management capacity enhancement were observed. Low hanging fruits technical and non-technical improvements works had been finished in the treatment plant, in the course of six months of the implementation. Longer institutional reorganisation that needs multi stakeholders' agreement and senior-level approval were also made in the districts that will affect the planning and budgeting capacity, and will lead to substantial improvement in manpower, O&M, and services in longer term. Political process is needed in the parliament that needs further follow-ups.

There are several learnings from the implementation phase. First, significant improvements only can be addressed in comprehensive approach, topic-wise (institutional, management, and technical) and strategy-wise (comprising advocacy, institutional improvement, technical assistance, capacity improvement). Second, the level of multi-sectoral collaboration within the district, and support from the high-level decision makers are essential to ensure long-term and sustainable transformation. The province can play its role as 'knowledge broker' within its districts and organize the similar horizontal learning, to ensure that the learning processes are accountable, institutional supports can be provided, and future follow-up and replications can be facilitated. Third, the implementation during pandemic situation posed challenges and opportunity to the replicability. The usable cost was only less than 40% from the initial budget, with most of follow-up meetings and consultations were conducted virtually. The exploration of different ways of implementation approaches cuts the cost drastically and forced all the involving parties to adapt while ensuring the process were still as effective.

Development of Community Behaviours Towards Clean Sanitation to Reduce Stunting Prevalence: A Case Study

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Keywords: sanitation, stunting, behavior, community

Stunting is a failure of child growth and development as a result of poor nutrition considered shorter than the average age of children seen from the growth curve in who or $-2SD$ (Ministry of Health 2018; Kemendestrans 2017). The Indonesian government is still struggling to reduce the prevalence of stunting, because data from RISKESDAS (Ministry of Health 2018) shows that 30.8% of stunting prevalence, which is the second-highest in Asia after Cambodia (Rokx et al. 2018). Stunting is not just a child malnutrition problem, but also is a multidimensional problem. In this regard, cultural factors need to be taken into account, indicating that individual and community behaviors towards the hygiene environment are important to be targeted for knowledge and prevention of stunting. For example, healthy and hygienic behaviors in daily life along with the intervention of clean water and good sanitation facilities are important measures to be promoted. The government of Indonesia has emphasized the fulfillment of clean water and sanitation facilities (TNP2K 2018) as one of five measures to tackle stunting at the village level. Despite the government's effort, there are still many people in various regions behaving inappropriately related to sanitation. They use rivers and swamps for MCK (Bath, Wash, latrine) activities and therefore insufficient clean water sources cause poor sanitation, which consequently contribute to high levels of diarrhea in children. Based on the above-mentioned problems, improvement of hygiene behaviors is inarguably one of critical elements in solving the stunting problem in Indonesia.

The purpose of this study was to reveal the community behavior of the Ogan Komering Ilir (OKI) district on clean sanitation as one of the efforts to reduce stunting. This study employed a qualitative method that is case study approach. Data mining used semi-structured interviews and secondary document analysis.

The results of research to answer the question that since a few years before the government's efforts to tackle stunting, various efforts have been made to program healthy behavior activities related to sanitation. In OKI Regency, most of the area is crossed by rivers and swamps so that residents have cultural habits of MCK behavior in rivers and swamps as well as some in the land. The healthy sanitation activities have been targeted in remote areas because there are still many cultures of sanitary behavior that are unhygienic. Cultural behaviors on sanitation is gradually improved through the construction of several public toilet facilities and access to clean water at every point in several regional villages, representing the construction of MCK facilities, good Septic Tank, Posyandu and BKB campaigns. However, the challenge is that some residents still maintain MCK activities in rivers or swamps; these behaviors are seemingly difficult to be changed immediately. Specifically, there was no significant change in both sanitation behaviors through the stunting intervention campaign. On the other hand, changes towards good sanitation behaviors occurred as a result of programs that have long been carried out by the government. In addition, the present study demonstrated that it takes time to build awareness to build an independent MCK

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facility at for each household due to cost constraints, cultural value, as well as the mindset and habits of local people. In this sense, innovation in stunting reduction program is still minimal due to limited availability of funds and relying only on village and local funds. Also, the findings suggest that poverty is an obstacle in getting used to healthy sanitation behavior goes well in accessing sanitation services among underprivileged families who have to rely on limited sources, such as rivers, swamps and land as a means of MCK. In conclusion, there is a need for a multidimensional understanding and therefore approach to diminish/combat the stunting prevalence considering improved sanitation.

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Analysis of Methane Production from Septage Sludge of Various Age

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Keywords: anaerobic digester; biogas, renewable energy, septage sludge treatment

On-site sanitation (OSS) is widely used by approximately 71% of the total population in Indonesia. However, there is limited septage sludge emptying and treatment. To date, most treatment plants only compost their septage sludge which actually has the potential to be utilized to generate bio-methane for renewable energy. This study is aimed to analyze methane production from septage sludge of various ages in Jakarta and Depok City, Indonesia. A total of nine samples from faecal containment with various operational ages were collected. The samples were then represented in three categories, i.e. containment operating for 1–2 years, 3–10 years, and more than 10 years. The methane production was investigated by Biochemical Methane Potential (BMP) Assay for seven weeks with a mixture of Volatile Solid (VS) of substrate and inoculum of 2:1. Results showed that the methane yield of septage sludge ranged from 142 to 242 mlCH₄/gVS. Septage sludge characteristics of VS, Total Solid (TS), and COD did not correlate with faecal containment age. The containment operating less than three years has the best methane production hence nutrient recovery from septage sludge can be utilized as renewable energy potential. The result of this study can be used as a recommendation to the government in increasing the value of septage sludge treatment in Indonesia.

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Evaluation of Communal WWTP Performance Based on Technology Management in Kabupaten Sleman D.I. Yogyakarta

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Keywords: domestic waste water, communal WWTP, ABR, RBC

Communal WWTP is one of the solutions of domestic wastewater treatment when a city wide centralized WWTP is difficult to be implemented. Yogyakarta has a centralized WWTP that mainly covers the urban area of Yogyakarta except Sleman District. There are at about 130 Communal WWTP equipped with Anaerobic Baffled Reactor (ABR) and/or Rotating Biological Contactor (RBC) in Sleman District. However, there are very few studies comparing the performance of these two technologies from the management perspective. The purposes of this research is to know and evaluate the management situation of Communal WWTP as well as evaluate the effectiveness of Communal WWTP in Sleman Regency based on the processing technology used.

The qualitative data in this research was obtained from the tools (interview, questionnaire, and observation sheets) which were made based on the prevailed regulations such as PERMEN LHK No. 11 Tahun 2017, PERMEN PUPR No. 4 Tahun 2017, and PERMEN LHK No. 68 Tahun 2016 along with scientific journals from previous research. Data collection was conducted from January to March 2020. Due to the COVID-19 global pandemic, the data was collected through phone-calls and Google Forms. The data contains managerial, operational, community participations, and physical effluent conditions from 8 Communal WWTP in Sleman District based on the secondary data obtained from Sleman Environmental Protection Agency 2018. The qualitative data was converted to quantitative data using a scoring method to compare both technologies between ABR and RBC.

CWWTP with ABR has higher score on operational cost, unit failure and operational problems compared to CWWTP with RBC. However, the effluent physical quality of RBC scored higher than ABR. Comparing total score of CWWTP between ABR and RBC, it showed that the ABR reached commonly higher value than the RBC technology group (> 90%). On the other hand, CWWTPs with RBC has a total score below 85% and Condongcatur CWWTP has the lowest scoring percentage. These results shows that although CWWTPs with RBC are preferable in term of effluent physical quality, CWWTPs with ABR are better in term of operational cost, unit failure, and operational problems. Based on this study, CWWTPs with ABR technology is more effective for Sleman Regency, D.I. Yogyakarta evaluated by the operational costs and damages to the WWTP unit. However, further research is required to compare the effectivity of influent treatment effectivity between ABR and RBC.

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Loading Rate Estimation of Wastewater from Batik Industry in Yogyakarta Area, Indonesia

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Keywords: batik wastewater; risk assessment, hazard identification, loading rate estimation

Batik is traditional Indonesian textile product and becomes important economic sector. It is mostly run by middle to small scale enterprise and categorized as home industry. One characteristic of home industry is its limited capacity in many aspects especially environmental management. Wastewater from most factories are released to environment without proper treatment posing threat to human and environmental health. Risk assessment can be applied to estimate the magnitude of this threat. The initial step in risk assessment is hazard identification. Wastewater is one of the sources of hazard generated by this industry. As production method may differ among factories, the characteristics and wastewater quantity may also vary. This study presents the profile of production method used by batik industries which would affect its characteristic and quantity. Then it is used to estimate its loading rate to environment. Study focused on 53 (fifty-three) factories located in Bantul Regency Area, Yogyakarta special region, in Java Island. Wastewater characteristic was focused on organic-related parameter as regulated in Local Regulation of Yogyakarta Special Region No.7/2016 which are BOD₅, COD, and TSS. Samples were taken and analysed at laboratory. Data on production method especially related to water consumption and type of dyes and chemical used were collected through simple questionnaire. This data was then processed and used to calculate loading rate estimation. The results were plotted in map so that it can be estimated the loading received by receiving river through drainage system. The result can be used as the basis to develop the best strategy to control environmental impact of batik industry.

Out of the 53 factories in study area, 68% use both naphtol and indigosol type of dye in their production. High variation occurred in production capacity which ranges from 10 to 1,000 sheet of clothes per month. Related to production capacity is water consumption which ranges from 10 to 1,000 L / month. However, with r value of 0.581, this production capacity is not strongly correlated to water consumption. Different technique used to make batik may affect this condition. Direct painting technique called “*colet*” for example use very low amount of water. Other factors such as the type of dye and quality of batik product may also affect water consumption.

Laboratory analysis shows that the average value of BOD₅, COD and TSS of wastewater samples were 55, 12.583, and 1,993 mg/L respectively. Value of COD and TSS were higher compared to other studies due to concentrated wastewater sample and high variation of production method. This high organic concentrated wastewater was discharged to two different watersheds of the study area, Opak and Progo Watershed. By plotting to related map, the organic loading received by each watershed can be estimated. By referring to Local Regulation of Yogyakarta Special Region No.7/2016, the maximum allowable load can also be calculated. Comparing the results, it is concluded that without sufficient prior treatment, organic loading from batik factories in Bantul Regency will exceed allowable discharge to environment.

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Improvement of Municipal Waste Management Using Dynamics System and Zero Waste Index Approaches in Bandung City

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Keywords: dynamics system, municipal solid waste, zero waste index

Proper solid waste management (SWM) is one of the key components to achieve sustainable development. Indonesia has targeted 30% of waste reduction and 70% of waste handling from the total amount of waste generated by every municipality. As one of metropolitan city in Indonesia, Bandung must develop and implement a local policy in handling waste's problems, following the national targets as aforementioned. SWM master plan of Bandung was formulated as short-term (2017–2020), mid-term (2021–2025) and long-term (2026–2037) targets. To ensure its efficiency and to achieve the targeted goals, the existing performance of SWM practices of Bandung city needs to be measured objectively. This study aimed to identify and to evaluate the performance of the existing SWM in Bandung. It examined the performance of the municipal SWM system, which was conducted through the three steps, (1) development of a municipal waste management system model, (2) projection of the total reduction and handling of municipal solid waste within the different policies scenario and (3) measurement the performance of the municipal SWM system. This study proposed a hybrid approach to measure Bandung SWM performances using dynamics system and zero waste index (ZWI). At the first stage, the dynamics system was performed to project waste stream as it reduced by the formal, semiformal and informal sectors before disposal at landfill. Subsequently, these results were used as inputs of the ZWI to forecast the amount of virgin materials that were recovered from waste streams. The result showed that the efficiency of waste reduction was of 9.6% and waste handled by SWM system was of 83%. Total amount of waste handled by Bandung City is 540,526 tonnes/year with waste recycled at 28,732.3 tonnes/year. Furthermore, the ZWI of Bandung was found to be 0.05. The ZWI of Bandung showed that only around 5% wastes were recovered or potentially substituted between 2019 and 2020. In the future works, the combination between the dynamics system and the ZWI will be applied to identify them most important priority areas of SWM towards zero waste under different scenario.

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Current Overview of Polyethylene Terephthalate as Biofilm Media in Communal Wastewater Treatment Plants in Indonesia

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Keywords: biofilm media, Indonesia, polyethylene terephthalate, settlement, wastewater treatment plant

Currently, there are two types of community-based (Sanimas) wastewater treatment plants (WWTPs) being developed in Indonesia, namely Anaerobic Baffled Reactor (ABR) and Anaerobic Filter Reactor (AFR). Polyethylene terephthalate (PET) from bottle waste has been used as biofilm media for AFR. The AFR consists of vertical PET-bottle beds, which act as support for biomass. The aim of this study was to overview the effectiveness of PET in organic and nutrient removals in communal WWTPs in Bandung, Indonesia. Raw wastewater samples were taken from eight WWTPs; four ABR (W1-W4) and four AFR (W5-W8), which were located at Kelurahan Neglasari–Kecamatan Cibeunying Kaler, Kelurahan Maleer–Kecamatan Batununggal, Kelurahan Binong–Kecamatan Batununggal, and Kelurahan Sukabungah–Kecamatan Sukajadi. The sites were in low-income communities (Masyarakat Berpenghasilan Rendah, MBR) and densely populated environments (more than 159 people/hectare).

The results show that AFR using PET as support media performed better than ABR. TSS, COD, BOD, and ammonia removal efficiencies of ABR were 29.14%–61.16%, 12.04%–58.99%, 37.52%–78.22%, and 1.39%–20.21%, respectively, while AFR were 49%–81.89%, 42.74%–86.11%, 69.19%–87.20%, and 20.72%–25.58%, respectively. PET has the desired properties as a biofilm media: inert, not easily degraded biologically, easily formed, rust-resistant, lightweight, and enable attachment of microorganisms in large numbers with a small risk of deadlock.

Although the AFR effluent still did not meet the quality standards of the Indonesian Minister of Environment and Forestry Regulation (PermenLHK) No. 68 of 2016, however, the addition of PET media had been able to improve the treated water quality. In general, there is still a need to add an aerobic unit process to the current process, especially for ammonia treatment. Ammonia removal efficiency is still low because all WWTPs do not have aerobic units, so it is necessary to add an aerobic unit.

As pointed out above, different types of ABR and AFR were investigated briefly. The results of this study show that PET is a potential biofilm media for WWTPs. Ultimately, the addition of an aerobic unit or a combination of anaerobic-aerobic with PET media is required to obtain a greater removal than the current condition. Further research and further developments on the applied systems are necessary to overcome challenges on communal WWTPs.

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Association of Fecal Contamination and WASH Conditions in a Zambian Peri Urban Community

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Keywords: Escherichia coli, fly, water, toilet

Poor sanitation, water and hygiene (WASH) often cause serious fecal contamination. Peri-urban communities in low-income settings have poor WASH conditions, leading to exposure risk of fecal microorganism with complicated transmission pathways. However, studies focusing on the association of faecal contamination and WASH conditions in peri-urban context are limited. Hence, this study aimed (1) to assess the faecal contamination levels in various media in the living environment, and (2) to associate the fecal contamination levels of environmental media by the WASH conditions in the peri-urban Lusaka, Zambia.

The present study was conducted in two peri-urban areas: Chawama and Kanyama compounds in Lusaka, Zambia. Firstly, on-site investigations were done to obtain WASH conditions including water-use activities and distance of the toilets and wastes from the houses. Secondly, *E. coli* tests were conducted on samples: stored tap water ($n = 24$), shallow well water (12), cup surfaces (37), plate surfaces (23), toilet floor (24), toilet entrance floor (24), house entrance floor (24), kitchen floor (25), flies inside a toilet (35), flies outside a toilet (42), flies at a polysack waste bag (46), flies at house entrance (42) and flies in a kitchen (35). Water samples were collected using sterilized sampling bags and surface samples were collected by using swab test kits. Fly samples were collected from sticky fly tapes hung at different locations around houses after left for an hour.

Results show several important findings: (1) certain media around toilets without roof had significantly more contamination and more flies than that of toilets with roof, (2) as water sources for cleaning kitchenware, shallow well water was significantly more contaminated than stored tap water, (3) cups and plates washed by shallow well water were more contaminated despite insignificant, and (4) media in kitchen had more contamination when they were located closer to waste bags and closer to toilets. The results implied that the fecal contamination levels of environmental media were associated with the sanitary conditions in the study sites. Countermeasures were suggested to improve the WASH conditions: to select tap water over shallow well water for washing kitchenware, to provide roofing on toilets, and to keep toilets and waste bags farther from the kitchens.

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Exploration and Identification of Novel Anammox Bacteria in Indonesia

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Keywords: anammox, Lake Koto Baru, FtBR, Indonesia

Dissolved and accumulated fertilizer from agricultural land surrounding Lake Koto Baru, Indonesia, promote eutrophication. This condition could be a possible condition for anaerobic ammonium oxidation (anammox) bacteria that corresponds to oxidized ammonium into nitrogen gas using nitrite as electron acceptor anaerobically. The purpose of this study was to explore and to identify the anammox bacteria using sediment from Lake Koto Baru, Tanah Datar, Indonesia, as seeding sludge. The sludge was inoculated to a 1.5 L novel filter bioreactor (FtBR) for enrichment with a string wound filter as supporting media for biofilm. The mineral medium supplemented with 70–150 mg-N/L ammonium and nitrite was fed into the reactor through the inside of the filter with a 24-hr hydraulic retention time (HRT), continuously. FtBR was operated at room temperature (Run 1) and 35°C (Run 2). Influent and effluent water samples were collected twice a week for ammonium, nitrite, and nitrate concentration analysis based on the standard method. DNA of biofilm samples were extracted for microbial community analysis using Illumina Miseq sequencing. The performance of nitrogen removal in Run 1 was higher than Run 2 of which 98.19%, 92.95%, and 0.303 kg-N/m³.d for Run 1 and 88.61%, 68.93%, 0.214 kg-N/m³.d for Run 2, respectively. After 140 days of operation, a red biofilm covered filter carrier in Run 1 whereas black observation in Run 2. Phylogenetic affiliation of anammox species belong to genus *Candidatus Brocadia* and *Candidatus Anammoxoglobus* enriched. Two novel Candidatus-like species were predominantly discovered, were of 20.04% and 6.20%, respectively. The rare *Candidatus Anammoxoglobus propionicus* growth and predominant was found in Run 2, was were of 7.64%.

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Preliminary Study on the Potential Utilization of Oil Palm Biomass for Tissue Paper: A Life Cycle Perspective

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Keywords: oil palm biomass, tissue paper, global warming potential, life cycle assessment

The current covid-19 pandemics has made the use of sanitary products such as tissue papers increasing significantly around the globe, including in Indonesia. Several efforts have been initiated to study the application of biomass to substitute the wood-based pulp for the paper. Indonesia is one of the leading palm oil producing countries in the world that generates more than 200 million tonnes of residual biomass comprising of fronds, empty fruit bunches, trunks, shells, and mesocarp fibres. These biomasses can potentially substitute wood in pulp and paper production.

This study will investigate the potential application of oil palm biomass for tissue paper production. The environmental aspect of substituting the existing raw material with oil palm biomass will also be evaluated using life cycle assessment. The scope of the study is from cradle to gate, i.e. from the extraction of biomass raw material at oil palm plantations to tissue producers. The functional unit used is per kg of tissue paper with the inventory of production process is mainly based on the available database (Ecoinvent 3 Database) and from the literature that has been adjusted using Indonesian Dataset. The LCA methods are based on Indonesian National Standards SNI ISO 14040:2016 and SNI ISO 14044:2017, with the impact assessment using IPCC GWP100a.

According to the preliminary study, it is estimated that 0.32 kg CO₂-eq can be avoided from raw material substitution and transport, therefore, the total emission from oil palm biomass-based tissue paper is 1.56 kg CO₂-eq/kg. Electricity consumption is located as the hotspot, therefore, further study can be developed to improve the utilization of electricity, such as reducing energy loss, generating self-power plant, using renewable energy source other than fossil mix (e.g., mini-hydropower plant, wind power plant), etc.

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The Quantity, Quality, and Treatment of Wastewater from the Tofu Industry in Giriharja, Sumedang, West Java, Indonesia

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Keywords: tofu industry, wastewater, whey, non-whey, anaerobic wastewater treatment plants

Consumption of tofu in Indonesia is steadily increasing as tofu is a relatively cheap source of protein that is easy to find and to make. The fact that untreated wastewater from tofu production can be broken down easily has a negative impact on the environment. An observation had been done in a village called Giriharja as one of the tofu production centers located in Sumedang Regency, West Java, Indonesia. In Giriharja, there are 9 small scale tofu industries with five of it produce white tofu and four produce yellow tofu.

From observations, tofu production process begins with soaking 10.62 L of soybeans for \pm 2 hours, rinsing the soaked soybeans, grinding the soybeans into soybean porridge, boiling the porridge, filtering the cooked porridge to get the soybean milk, adding coagulant to soybean milk, and pressing the coagulated curd as tofu. Until this point, it produces white tofu. The yellow tofu will be made by cooking the cutting white tofu in a solution of water, salt and grinded turmeric. The white tofu pieces will turn to yellow color just on surface area due to the turmeric yellow color, then it will be cooled down on clean water and packed.

The average production of white tofu per day requires in total 1.05 tons soybean, while for yellow tofu it requires 0.98 tons. It could be measured for 2 tons tofu production capacity per day it consumed 64 m³ of clean water, and produces 62 m³ of wastewater.

In the study, observation on tofu wastewater based on the predicted organic contents could be divided into two types, namely whey and non-whey. Whey wastewater comes from the coagulation process and pressing the tofu. Non-whey wastewater comes from remaining soaking water from soaking soybeans, turmeric containing cooking water, and cooling water. Wastewater characteristics were measured by turbidity, pH, TDS, TS, VS, COD and BOD₅. The results showed that both types of wastewater did not meet the quality standards set by the Indonesian Ministry of Environment (2014). The whey wastewater will be treated by the anaerobic Wastewater Treatment Plants (WWTP), while non-whey wastewater will be dumped directly into the sewer. Whey that goes into the Anaerobic WWTP inlet in average reaches 20 m³/day and produces biogas 700 m³/day. Biogas will be distributed to 87 households in Giriharja.

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Interventions for Last Mile Districts: Achieving 100% ODF in Pangkep District in South Sulawesi

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Keywords: open defecation free, last-mile intervention, South Sulawesi

Indonesia has nationally reached an average of 79% access to at least basic sanitation (MoH 2020). Among 34 provinces in Indonesia, South Sulawesi Province is currently in the second position on sanitation access with 96.75% (MoH 2020) and on track to become the second open defecation free (ODF) Province in Indonesia. Nine of the 24 districts in South Sulawesi have eliminated OD, with the other districts are trailing with 89–99% access. However, since 2019, only five districts have fully moved from the ‘almost elimination’ status into fully ‘100% elimination’ of OD. This study aimed to identify the determinant factors that enable and hinder the achievement of universal access to sanitation from the current level of sanitation access in Indonesia. This should answer the question on how to accelerate the progress and how to ensure the equitable access by addressing the ‘last-mile’ communities.

A field survey was conducted in one district in South Sulawesi Province with high access of sanitation, but not yet achieve ODF status, i.e. Pangkep District. Within the district, several focus group discussions (FGDs) were conducted in the community with verified ODF status and the community without ODF status. Interviews were also conducted with districts, sub-districts, and village authorities to understand the enabling environment on the sanitation access improvement. Field observations were made on the villages to find out the actual quality of latrines built by the community and how the community obtain them.

The study confirms the previous findings that small groups of households in a community that do not yet have access are often the ones facing the most difficult challenges, including geographical conditions, and thus require a different additional approach. Low-quality triggering, dependence of target communities on external funding/assistance mechanisms, lack of progress monitoring after triggering, and low cooperation spirit within the community are found to be the dominant factors that attribute to the reluctance of the community to build their latrines.

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The Urgency of Water Resources License Rule in Anjongan Area, West Kalimantan Province

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Keywords: water resources license, water management rule, Anjongan area

Many springs are found in the Anjongan area, located in Mempawah Regency, West Kalimantan Province, wherein other regions rarely found caused by the land structure. These springs have contributed to supply, trade and distribution of water to some regions in West Kalimantan Regions such as Mempawah District, Landak District, Kubu Raya District, Singkawang City, Pontianak City. The interesting thing is that most of the population in the spring area are water sellers. However, most sellers do not have official business permits. The situation can have long term impacts on the environment and public health. This research aims to describe the urgency of water management rule through social law research methods and the legal health aspects.

Water resources management is a process that encourages integration between the development and management of water, land and other resources, to maximize socio-economic welfare and to pay attention to ecosystem sustainability. The 1945 Constitution of The Republic of Indonesia in Article 33 (3) mentioned that “The land and the waters and the natural wealth contained in it shall be controlled by the state and utilized for the optimal welfare of the people”. The words “controlled by the state”, did not mean those were owned by the state, the private sector would be permitted too. The control gave the certainty that water management ought to be done by the state for the optimal welfare of the people. The Ministry of Health regulated the 43rd Minister Health Regulation of 2014 concerning Hygiene Sanitation of Drinking Water Depos; it considered that the community needed to be protected for the water risk diseases which does not fulfil standards hygiene sanitation. The research found that Local Governments should make specific rules regarding water resources management based on Indonesian laws and regulations, including the obligation of traders to obtain official business permits.

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Co-Creation Practices on Sanitation in the Communities of Cameroon

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Keywords: sanitation value chain, co-creation, Cameroon, COVID-19

This study reports on the current situation of sanitation and the search for an ideal design that practices each of the slum areas in the capital, rural area of local cities, and forest areas in Cameroon, central Africa. This research is conducted in collaboration with Japanese researchers, Cameroonian researchers, local NGOs, and each resident of the communities.

Collaborative research with the local NGO called Tam-Tam Mobile, in the capital city of Yaoundé is focusing on the activities of the local government and residents' organizations regarding efforts to improve hygiene and sanitation in some slum communities. In the slum areas, where nearly 70% of Yaoundé's residents live, the problems of domestic wastewater, toilets and garbage are serious. The local NGO called Mutcare, which is based in Bertoua, the capital of the eastern state Cameroon, has been promoting the spread of WASH in the surrounding rural villages, and as part of its activities, they had been installing toilets in some villages of settled hunter-gatherers. Currently, based on this practice, we are conducting an experimental trial of fruit tree cultivation for effective utilization of the site of the toilets. Similarly, the local NGO called Association Okani based in Bertoua, have been working to protect human rights and improve the living environment of settled hunter-gatherers. They have been asked to try to understand the hygiene/sanitation situation in a wide range of settlements. Especially around the eastern province of Lomie city, we have been conducting joint research on the installation status of toilets and try to understand the patterns of excretion behavior by hunter-gatherers.

On the other hand, since March 2020, due to the impact of the COVID-19 in Cameroon, infection prevention measures have been promoted at all survey sites, and each NGOs has improved public health for each community. And they have continued activities including some campaigns with distribution of necessary supplies. While Japanese researchers are restricted from traveling to Cameroon, we continue to share information and seek joint research through online exchanges. We continue to pursue better sanitation situations in each field in/after COVID-19 with researchers, local organizations, and residents of each community.

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Perceptions and Potential Reuse of the Effluent from Anaerobic Wastewater Treatment Plant (WWTP) Treated Tofu Wastewater

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Keywords: perception of farmers, potential reuse, anaerobic wastewater treatment plant (WWTP), WWTP effluent

An anaerobic Wastewater Treatment Plant (WWTP) in Giriharja Hamlet, Indonesia processes approximately up to 40 m³/day of tofu whey from nine tofu industries. The effluent or treated water from WWTP could be used as an alternative water source for agriculture in the area, particularly during the dry season. However, the acceptance of farmers and the willingness to use WWTP effluent are important considerations. Farmer perceptions and the factors that influence them were obtained through interviews and the data analyzed with Likert scale and ordinal logistic regression models. Analysis of physicochemical properties shows that the parameters pH, TDS and DO of WWTP effluent met the criteria for irrigation water according to Indonesian Government Regulation Number 82 of 2001 concerning Water Quality Management and Water Pollution Control. Water quality Class IV can be used to irrigate crops and/or for other uses that require the same water quality for that purpose. Most of the respondents strongly agreed that the treated water still slightly smelled, but they also agreed that it was no longer harmful to the environment. Based on the survey of the potential reuse of WWTP effluent, only 36% farmers as respondents tend to doubt that it contains fertilizer for plants but still 44% of farmers could justify that effluent is reusable for crop irrigation. The analysis shows that younger farmers were more high acceptance to re-use the effluent than the older farmers.

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Assessment of The Impact of Toluene Exposure on Urinary Hippuric Acid Concentration of Batik Workers in Special Region of Yogyakarta, Indonesia

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Keywords: batik, exposure, hippuric acid, risk factor, toluene

Toluene is one of the toxic organic compounds found in the batik working area that can cause both acute and chronic health effects with the central nervous system being the main organ target. Toluene released from the production area may expose workers and induces health problems. Insufficient design and quality of the ventilation system on home-scale industries, also minimum usage of personal protection equipment may exacerbate the level of exposure.

This research assesses the risk of toluene exposure by measuring inhaled toluene and urinary hippuric acid as its biomonitoring compound. Hazard index of toluene exposure and odds ratio of risk factors on toluene intoxication are calculated. Urinary hippuric acid concentrations were also measured and compared with the ACGIH standard. A cross-sectional study was conducted in three different batik industries with a total of 56 respondents located in the same area in the Special Region of Yogyakarta, Indonesia. The exposed group is production workers in batik industries while the control group is resident who is not working as a batik producer or being exposed to toluene. Interviews were done to gather information about attributes, working histories, and lifestyles that may be a risk factor of toluene intoxication. Inhaled toluene concentrations were collected using a personal sampler pump and measured using GCMS meanwhile urinary hippuric acid was measured using HPLC-UV.

Preliminary data analysis shows that more than 30% of respondents experiencing tiredness and difficulty to concentrate, and more than 40% experiencing headache, numbness in feet, and sleeping disorder which are symptoms of toluene intoxication. Current data analysis showed that workers who work using batik wax have a higher probability of increasing urinary hippuric acid levels (OR 13.33, p-value < 0.05). Further data analysis on inhaled toluene and its correlation with urinary hippuric acid concentration are expected to give an increasing health risk level on workers compared to the control group. Other than that, calculation of odds ratio of age, gender, working period, work division, type of working area, and smoking habits using logistic regression analysis may give information about additional risk factors and cofounding factors of the outcome.

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Assessment of Sanitation, Hygiene and Health Status of Primary School Children in a Zambian Slum

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Keywords: Sustainable Development Goals (SDGs), Water, Sanitation and Hygiene (WASH), nutrition, Zambia

Background: The 2030 Agenda for Sustainable Development Goals (SDGs) stipulate that no child should get sick, die, or fail to attend school because of poor water, sanitation and hygiene (WASH). The agenda recognizes good water, sanitation and hygiene as important facilitators for many other goals such as nutrition. Sanitation and nutrition security remain a big public health challenge in Zambia and other developing countries of sub-Saharan Africa. Zambia has persistently registered a high stunting rate of over 40% since 1992. Information of health, nutrition and growth patterns of children from the age of 5 to 17 is very scarce and unclear despite most of the population (> 60%) being under the age of 25. This is an ongoing research conducted to assess sanitation, hygiene, health and nutrition status of primary school children from age 5 to 15 in a peri-urban area of Lusaka, Zambia.

Method: Participants were 1300 children of ages 5 to 15 years from one private primary school, and one public/government primary school. A WASH observation checklist based on WHO and UNICEF criteria was used to assess WASH facilities at both schools. In addition, participants' date of birth was collected and height and weight anthropometric measurements were recorded. Measurement of children's body weight (Weight-for-age Z-score: underweight) and height (height-for-age Z-score: stunting) will be used to analyze the nutrition and health status of the participants

Results: Observation of sanitation and hygiene facilities indicated unimproved, damaged and few numbers of toilets were available at government school. Improved and sufficient sanitation and hygiene facilities were found at the private school. As for anthropometric measurements, analysis of results is still in process. However, we expect the results to indicate high malnutrition challenges (underweight) in children from government schools with those from private schools being healthier and some, overweight.

Conclusion: School-aged children at government school are at higher risk for WASH-related morbidities than those at private school. Theft and vandalism hinder success in maintaining good sanitation and hygiene standards especially in government schools. Training and community sensitization can help improve WASH standards altogether.

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An Assessment of Sustainable Solid Waste Management and Occupational Health in Lusaka, Zambia

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Keywords: sustainable, solid waste management, landfill, treatment, dumpsite, health

Background: Globally, around 1.3 billion tons of garbage is generated daily, translating into each city dweller generating about 1.2 kilograms per day. Sub-Saharan Africa generates approximately 62 million tons of garbage yearly. Similarly, the amount of waste is rising due to population increase, changes in lifestyle and increasing urbanization. The study investigated the challenges of sustainable Solid Waste Management (SWM) in Lusaka, Zambia's capital city. The problem of SWM became more complicated in recent years and required sustainable long-term strategies and solutions, as less than 20% of the collected solid waste in Lusaka was disposed of properly.

Methodology: Data collection comprised of naturalistic observations at the main dumpsite in Lusaka and one-on-one interviews with nine waste management companies engaged in waste collection. Interviews were also conducted with Lusaka City Council (LCC), the government institution mandated to supervise SWM activities in the city making a total sample of 10. Interview questions focused on understanding the current situation of sustainable SWM in place, particularly the treatment process after disposal.

Results: Several challenges affected an efficient sustainable SWM system; lack of waste separation at source, inadequate funds to sponsor SWM activities and lack of treatment equipment at the dumpsite. All companies indicated that their primary role in SWM was collection and disposal. Most of the companies were secondary waste collectors, whereas the majority of the Community Based Enterprises (CBEs) were primary collectors. Majority of the CBEs used the waste for other purposes, whilst companies did not. At the dumpsite, machinery was inoperative. Only one incinerator catered for the whole city and workers lacked proper Personal Protective Equipment (PPEs).

Discussion and Conclusion: LCC's role was to supervise SWM activities, conduct routine inspections of companies, and enforce SWM laws. Workers worked in poor conditions because they could not afford proper PPEs. Lack of equipment, resources to purchase new equipment and failure to repair broken down machinery both limited and made the treatment process unsustainable. The dumpsite only facilitated indiscriminate dumping rather than use of landfill method. This research recommends that more financial attention should be given to SWM activities and political will to enforce a proper revenue collection system.

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Menstruation and Menstrual Hygiene Management Practices among Females in an Urban Slum of Indonesia

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Keywords: menstrual hygiene management, menstruation, sanitation, Indonesia

Background: Menstrual Hygiene Management (MHM) plays an important role in women's well-being. MHM relates to different factors such as region, culture, religion, and sociocultural values. In particular, some challenges exist in the MHM practices of low and middle-income countries due to varying types of knowledge and education on MHM, and availability of menstrual products. Our objectives were to investigate methods of menstrual blood treatment and used menstrual product disposal to reveal the challenges of menstrual management and disposal.

Methods: Study participants were 32 adult women living in a densely populated area of Indonesia. We conducted a questionnaire survey with in-depth interview. The questionnaire included socioeconomic characteristics, menstruation and MHM-related questions.

Results and Discussion: A total of 26 participants had regular menstruation; six experienced irregular menstruation. About 80% of participants experienced normal bleeding duration. Disposable sanitary napkins were participants preferred product for treatment of menstrual blood (100%). This is likely due to Islam's view of menstrual blood as impure. The frequency of changing menstrual products per day was not high however, putting the user at risk of infections and other health problems. Our research found a menstrual waste disposal practice which was divided into four main steps: 1) wash away the menstrual blood on used napkin; 2) squeeze the napkin to remove any excess water and wrap the napkin; 3) dispose of wrapped napkin into the trash bin; and 4) wash hands. Between steps 1 and 2, a part of napkin was occasionally removed and thrown into the toilet. Washing of napkins may be a common practice in the area influenced by socio-cultural values.

Conclusion: Our study highlighted menstruation and MHM among women in an urban slum of Indonesia. Through the investigation, it became clear that the challenge in this area was not so much the women's menstruation, but rather the infrequent treatment of their menstruation. In order to solve challenges of MHM for women considering religious and socio-cultural factors, it may be necessary to clarify why they practice MHM as they do.

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Infant Oral Contact and Alloparenting in a Hunter-Gatherer Society in Cameroon

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Keywords: pathogen exposure, alloparenting, hunter-gatherer, Cameroon

Background: Diarrhea is the leading cause of death in children worldwide. Oral exposure to pathogens is the basic concept of the fecal-oral route associated with intestinal infections. Especially, in rural and low-income peri-urban slums, infants tend to crawl and play in areas where they may have a risk of coming into contact with contaminated soil. Infant parenting activities may play an important role in preventing these infections. In hunter-gatherer societies, mothers face trade-offs between time spent in food acquisition and parenting due to a wide range of physically demanding activities (hunting and gathering). Alloparenting, in which persons other than the biological parents take up childcare and daily activities on their behalf, is therefore a common practice. This study aimed to explore how infant oral contact behavior and alloparenting were related to infant's diarrhea.

Methods: The research areas were three settlements inhabited by Baka, hunter-gatherers in Cameroon. The participants were 6 infants and 29 of their caregivers (including parents). This study used two methods: interviews and direct observations (focused on oral contact and alloparenting). Diarrhea incidence information was collected through interviews. The names and frequency of all objects that came in contact with the infant's mouth were recorded. The duration of each caregiver's parenting activities was recorded by the minute. Both observations were conducted at the same time, the total observation time per infant being 6 hours, from 7:00 to 13:00.

Results and Discussion: Comparison of the number of oral contacts and infant's diarrhea showed no association. However, no infants came in contact with feces, and only one infant came in contact with soil. Therefore, the risk of infection from materials observed was considered low. The relationship between diarrhea and the number of caregivers per infant suggested that infants who did not have diarrhea tended to have more caregivers. This result might be due to shared attention for childcare and increased parenting time. There was no relationship between the number of hours of parenting activity and the number of object contacts. This might have been affected by infants' individual characteristics and their environment.

Conclusion: The risk of fecal-oral contact among hunter-gatherer infants could be low, and the number of caregivers in childcare may be related to diarrhea morbidity. Further study with a wider participant sample is needed to pursue these associations in the future.

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Knowledge, Attitude, and Practice of Hygiene Associated Gross Motor Development Delay among Children in a Suburban Area of China

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Keywords: child development, gross motor milestone, knowledge attitude and practice, water sanitation and hygiene

Background: Nearly 250 million children under the age of five have been reported as unable to achieve their developmental potential in low- and middle-income countries. In the underdeveloped areas of China, a high prevalence of children under the age of three experience motor developmental delay. Moreover, the burden of infectious disease is significant among low-income families with poor access to safe water, sanitation, and hygiene (WASH). However, the risk factors associated with child gross motor development remain unclear, particularly related to WASH. This study thus aimed to determine the gross motor development of children and investigate WASH factors contributing to motor developmental delay.

Methods: A cross-sectional study was conducted in a suburban area of China; 132 children and their caretakers participated. Data were collected via anthropometric measurements and a questionnaire. Children were weighed whilst lightly clothed and shoeless. Recumbent length (children < 24 months old) and height (children ≥ 24 months old) were also measured (shoeless). The questionnaire inquired about: (1) the sociodemographic characteristics of the participants, (2) the caregivers' knowledge, attitude, and practices (KAP) on hygiene, and (3) the child's gross motor development.

Results: The majority of the children (60%) were cared for by their mother, whilst 40% of them were primarily cared for by their grandmother. The child nutritional status was generally good in this study, with approximately 20% of the children experiencing delayed achievement of certain gross motor milestones. A significant difference in hygiene KAP was found between different caretakers. Compared to mothers, grandmothers had significantly lower hygiene KAP scores. Lower hygiene KAP scores were found to be significantly associated with a higher prevalence of child diarrhea, and significant predictors of the delayed achievement of walking with assistance.

Conclusions: Consequently, a superior hygiene KAP potentially improved child motor development in the examined suburban area of China. Proper personal hygiene and food hygiene KAPs are essential for combatting the transmission of infectious diseases and safeguarding the gut health of the child.

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Financial Feasibility of Scheduled Desludging Service in Tangerang Regency, Banten

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Keywords: faecal sludge, scheduled desludging, financial feasibility, Tangerang Regency

Currently, faecal sludge has not been managed effectively, especially in term of faecal sludge collection from residential septic tanks. Many residents do not drain their septic tanks regularly due to the high cost of desludging services. In addition, not all the owners of septic tank desludging service business understand how to manage faecal sludge, so they might dispose of the sludge in inappropriate places such as a body of water or open land. This action is contrary to one of the sustainable development goals (SDGs) in the field of sanitation, which is to end open defecation.

Scheduled desludging is one of the Indonesian Government's programs in collaboration with USAID-IUWASH in supporting SDGs 2030 in the sanitation sector. Tangerang Regency is one of the regencies that received assistance to scheduled desludging since 2017. The Tangerang Regency Government launched the scheduled desludging program at the Technical Implementing Unit of Wastewater Treatment Plant at East Sepatan District on October 10, 2019, by providing additional dung trucks and planning of two Faecal Sludge Treatment Plants (FSTPs) to treat sludge. Considering that the population of Tangerang Regency is quite dense, the government needs to increase the capacity of Lebak Wangi FSTP in East Sepatan District and build a new FSTP in Suradita Village, Cisauk District. It is expected that the scheduled desludging program can improve the equitable access and quality of safe sanitation.

The financial feasibility study will calculate the scheduled desludging program costs starting from the capital, technical, and non-technical costs. Several infrastructure investment scenarios will be explored for both FSTP and draining the septic tank, which costs will be borne by either the government or the private sector with several alternative forms of cooperation. The revenue will be projected from the dewatering and processing of sludge (emptying and discharge fee). In this study, the scheduled desludging program in Tangerang Regency will be planned for 20 years period, but the targets are divided into three stages namely the short-term (5 years), medium-term (10 years), and long-term (20 years) targets following the construction of the FSTP unit that will be carried out in stages. Finally, the financial feasibility will be assessed by calculating the value of the payback period (PP), financial internal rate of return (FIRR) and net present value (NPV) of all income and expenditure originating from the scheduled desludging activities. If the results of these calculations are positive, then the scheduled desludging program is financially feasible to continue in Tangerang Regency.

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The Ethics of Sanitation: Its Realms and Prospects

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Keywords: humanities, ethics of sanitation

Sanitation is not only limited to technology and the environment, but it is also embedded in society and culture. Although the sanitation issues have been studied mainly in the natural sciences and engineering, recently some of the social sciences and humanities discussed the sanitation issues, and several pioneering works emerged especially in the ethics of sanitation. This presentation shows the three topics on the ethics of sanitation and their importance in sanitation studies as a multi-disciplinary.

First, the ethics of sanitation contains the question of how sanitation technology should be. It is insisted that sanitation technology for low- and middle-income countries should not only be safe for humans and the environment but also low-cost and low-tech for sustainable development and wide implementation. Where this opinion is appropriate or not, the important point is that this opinion is explicitly based on a value judgment for sustainable development and it opens up the possibilities of a new discussion for examining the validity of value judgments themselves and the consequences derived from them.

Second, the ethics of sanitation involves the question of who and how should be done for sanitation work. Sanitation workers are suffered from stigmatization and health risks due to their works in some areas. In other words, the stigma and health risks from sanitation work are unevenly allocated to specific groups in a certain society. In addition to reducing the stigma and health risks as maximum, for example, it may be considered for the compensation in the form of honor and the assignment of economic benefits.

Third, the ethics of sanitation encompass the question of what sanitation facilities are appropriate as a basic human right. Appropriate sanitation facilities are not equal to mere latrines or toilets, but also should contain the consideration of privacy, gender, and the cultural context. It would require further study to assess the current situation is appropriate for these criteria and examine their validity.

The ethics of sanitation allows reexamining the value judgments which are a basis for the policies and technological developments on sanitation in the international community or in each country. It also contributes to better sanitation through the assessment of whether the current situation is appropriate or not in terms of a particular value judgment. In this context, the ethics of sanitation can explore a new field in sanitation studies as a multi-disciplinary.

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