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Current Situation of Solid Waste Management to Archive Sustainability in Klungkung Regency, Bali

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Abstract

Most of the area in Klungkung Regency has a waste management system that needs to meet technical requirements regarding the compartment, sorting, collecting, transporting, and processing. Coverage of handling urban waste is still far from the target of 80% in 2019 (46% in 2013), and the amount of waste generation that is still recycled is still minimal (4.95 m^3 in 2017). This research aims to make a master plan or strategy implemented to improve service coverage and the quality of solid waste management in the future. This research was conducted by conducting a direct survey and secondary data collection. The strategy adopted is to increase the utilization of waste infrastructure and facilities; increasing the capacity of solid waste facilities according to service targets; improving the quality of landfill management in the direction of sanitary landfills; developing regional final processing site management, and applying waste handling technology that is appropriate and environmentally friendly. The Millennium Development Goals (MDGs) contain the seriousness of improving sanitation conditions, which require increased public access to sanitation facilities in half of the population without access to sanitation. Increased population access to proper sanitation (domestic wastewater, solid waste and environmental drainage) to 100% at the level of basic needs.

Keywords: Klungkung Regency, waste management, waste infrastructure

Introduction

An increase in population will positively correlate with an increase in waste generation because each individual will produce waste daily in Bali (Suryawan et al., 2021). Waste management is an effort to overcome environmental problems from waste generation. Klungkung Regency is the smallest Regency of 9 (nine) Regencies and Cities in Bali Province with 315 km^2. The scope of the study area of the accelerated sanitation settlement development program in Klungkung Regency covers four districts, namely Klungkung District, Banjarangkan District, Dawan District, and Nusa Penida District. The environmental quality index in the Province of Bali by domestic and industrial activity might also be experienced by Klungkung Regency (SSK Kabupaten Klungkung, 2015).

This environmental quality index has three elements: air quality, water quality, and land cover level (RKPD Kabupaten Klungkung, 2020). Some problems related to waste management are that the amount of waste being recycled is still small. The target to be achieved is optimizing waste recycled through TOSS to reduce the volume of waste discharged to the landfill. There needs to be more optimal local waste management in urban areas and no more landfills operating in Klungkung Regency. Coverage of handling urban waste is still far from the target of 80% in 2019 (46% in 2013), as well as the amount of waste generation that is still recycled is still minimal (4,95 m^3 in 2017) (RKPD Kabupaten Klungkung, 2020). In the waste management sector, it is targeted that 80% of urban waste can be managed, and the remaining 20% can be managed in urban waste reduction facilities through 3R practices (reduce, reuse, recycle). Meanwhile, another 15% of Indonesia's population is targeted to have improved sanitation facilities and behaviors for low-density areas such as rural areas (Mara, 2017).

This study aims to make the strategies adopted to improve service coverage and the quality of waste

management. This is an effort to fulfil solid waste facilities and infrastructure, increase waste management service coverage for a clean and healthy life, and make the 3R (reduce, reuse, recycle) movement effective in the community.

Method

This research was conducted a survey to gather primary data directly from the sources. It is not specified what the survey was about, but presumably, it pertained to the topic of sanitation in Klungkung Regency. We also collected secondary data, which refers to data that was previously collected by someone else for a different purpose. In this case, secondary data was obtained from the 2016-2021 Klungkung Regency sanitation strategy document (SSK Kabupaten Klungkung, 2015). This document contained relevant information and statistics related to sanitation in the regionThe researchers reprocessed the secondary data to make it suitable for their study. It implies that they may have organized, cleaned, or transformed the data to fit their research objectives.

We used Geographic Information Systems, a software tool commonly used for mapping and spatial analysis, to determine the existing locations and plan their study. It suggests that they may have utilized GIS to map out the sanitation infrastructure or analyze the geographical distribution of sanitation facilities in Klungkung Regency. Finally, we conducted a discussion of the data using descriptive methods. Descriptive analysis involves summarizing and interpreting the collected data to provide a clear and concise description of the study variables. Additionally, they compared their findings with existing literature studies, which indicates that they reviewed and referenced relevant scholarly works on the topic.

Result and Discussion

3.1 Solid Waste Management Services

Semarapura City which is the center of the city and the center of government in Klungkug Regency. Klungkung Subdistrict is the smallest compared to other districts in Klungkung Regency, but the most solid waste generation is about 36.8% of the total waste generation in Klungkung Regency (Figure 1). After Klungkung Subdistrict, the highest solid waste generation was followed by Nusa Penida Subdistrict (26.8%), Dawan Subdistrict (19.9%), and Banjarangkan Subdistrict (16.4%). The solid waste generation rate in Klungkung is about 1.73 L/cap.day in Klungkung Subdistrict, 1.26 L/cap.day in Dawan Subdistrict, 1.17 L/cap.day in Banjarngakan Subdistrict, and 1.29 L/cap.day in Nusa Penida Subdistrict. The latest research conducted by (Widyarsana et al., 2020) states that the housing and municipal solid waste generation rate in Klungkung Regency is 0.37 kg/cap.day and 0.38 kg/cap.day. Klungkung subdistrict located in urban areas has a higher solid generation rate than other subdistricts in Klungkung Regency.

The composition solid waste generation in Klungkung Regency are food waste (18%), garden waste (50%), paper (4.2%), plastic (7.2%), metal (1.2%), textile (0.6%), rubber (0.9%), glass (0.1%), and others (17.9%) (Kementerian Lingkungan Hidup dan Kehutanan, 2021). The composition of transformed solid waste plastic, cans and iron waste to landfill is 40.0% in 2016. The problem of inorganic waste has yet to become a priority. An outline of the composition of solid waste generation in Klungkung Regency can be seen in Figure 2. These different characteristics of waste will affect the strategy and method of solid waste generation (Mega Muitiara Sari et al., 2023; Suryawan et al., 2022; Zahra et al., 2022). Solid waste generation can be a resource that will provide added value and income for the community (Mega Mutiara Sari et al., 2022; Suryawan & Lee, 2023, Suryawan et al., 2023). The reduction of plastic waste is also increased by Bali Governor Regulation No. 97/2018 concerning the limitation of disposable plastic/single-use plastic. The success of this program is driven by the commitment of the community and business stakeholders not to use disposable plastic/single-use plastic.

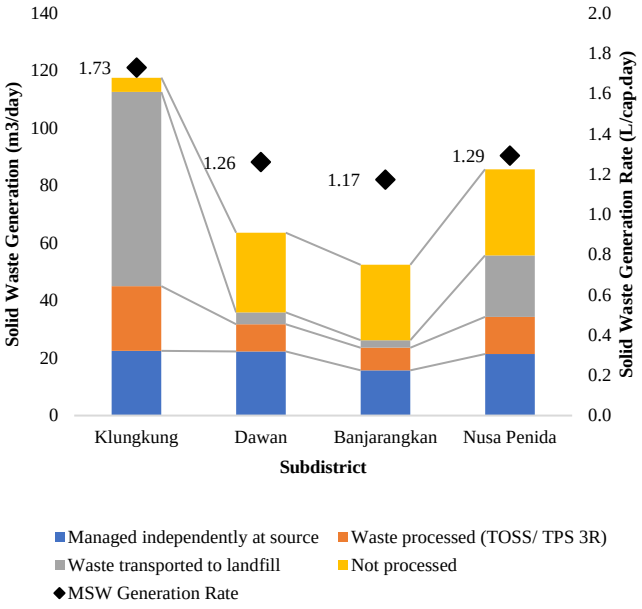

Figure 1. Solid waste generation, solid waste generation rate, and solid waste management in Klungkung Regency (SSK Kabupaten Klungkung, 2015)

The existing landfill services area in Klungkung Regency can be seen in Figure 3. Waste is collected in three landfill locations in Klungkung Regency (Figure 4). Two landfills are located on different islands, which are the Biaung Landfill and Lembongan Landfill. The three landfills were prepared to use the Sanitary Landfill system, but due to limited facilities and infrastructure and human resources so that the landfill system is still open dumping. Sente Landfill experienced overload in 2017 and needs to redesign landfills or choose a suitable new landfill location (Wijayakusuma & Satiawan, 2020)

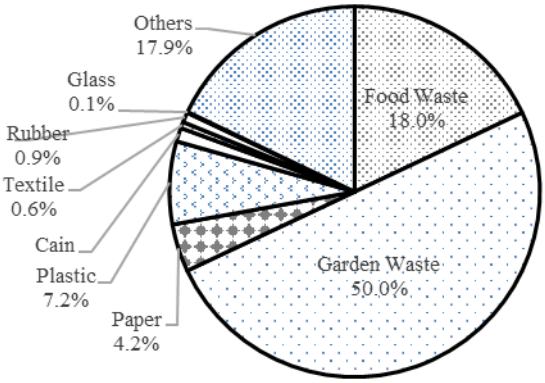

Figure 2. Solid waste composition in Klungkung Regency (Kementerian Lingkungan Hidup dan Kehutanan, 2021)

Sente Landfill service area consists of Semarapura Klod Village, Semarapura Kauh Village, Semarapura Kaja Village, Semarapura Kangin Village, Semodura Klod Kangin Village and Semarapura Village Central. In addition to the communities in the 6 locations, there are also communities in Akah Village, Kusamba Village, around Jalan Raya Banjarangkan and around the Sente Landfill. Nusa Penida Island, only four villages are served, namely Ped Village, Kutampi Kaler Village, Batununggul Village, and Toyapakeh Village. The Biaung Landfill with an area of 1.84 ha. The Lembongan Landfill, which covers an area of 0.90 ha, serves Lembongan Village and Jungutbatu Village. Continuous landfill maintenance needs to be done to make it easy to examine the condition of the landfill. The condition of the Sente Landfill monitoring well needs to be improved. Attention to the leachate treatment in each landfill is required.

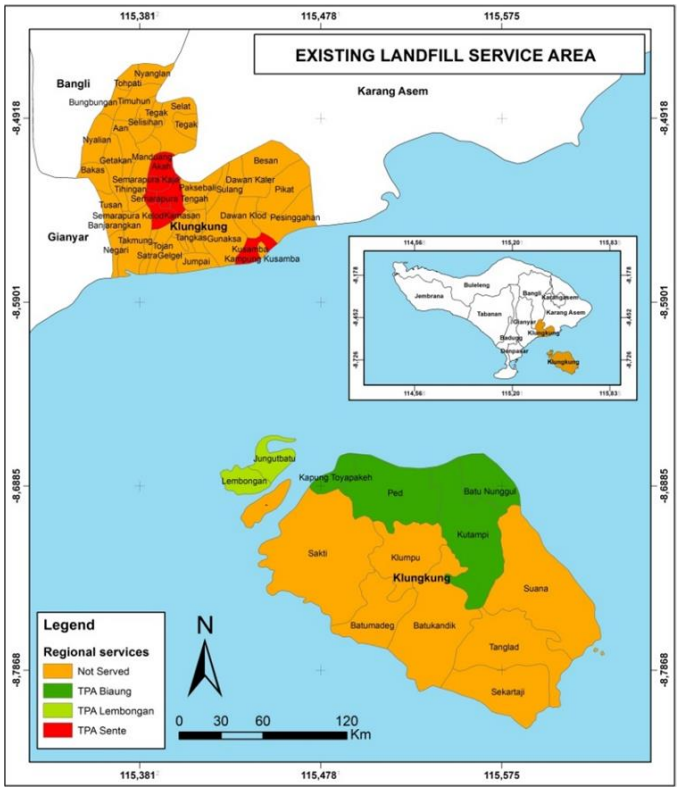

Figure 3. Existing landfill services area location in Klungkung Regency

3.2 Solid Waste Management

Klungkung Regency only has four amrolls trucks and thirteen dump trucks with two trip/day (Wijayakusuma & Satiawan, 2020). Waste transport in Nusa Penida Island and Nusa Lembongan Island must also be planned concerning suitable transportation systems. Considering that Nusa Lembongan Island and Nusa Ceningan Island have limited road segments, it is necessary to have a type of conveyance with a small size. Waste transportation in Klungkung Regency will be more efficient if it takes 26 trips/day and the addition of the number of dump trucks to 8 units for 2012 to 2016, while for the arm-roll truck, the ideal number of trips per day with eight hours with two trip/day (Pengelolaan & Sampah, 2013).

For locations that have not yet received waste transportation services because the limited facilities and infrastructure and operational costs. Self-managed waste management has been applied with several types of transportation facility assistance. For businesses or activities that produce more than 1 m^3/day of waste transported by themselves or collaborate with other parties such as villages or private parties [2]. Some waste sorting efforts are carried out by scavengers for recyclable waste while compostable waste is composted. The composting business still leaves waste that must be managed by requiring extensive land and high costs. The diagram of solid waste management in the Klungkung Regency can be seen in Figure 4.

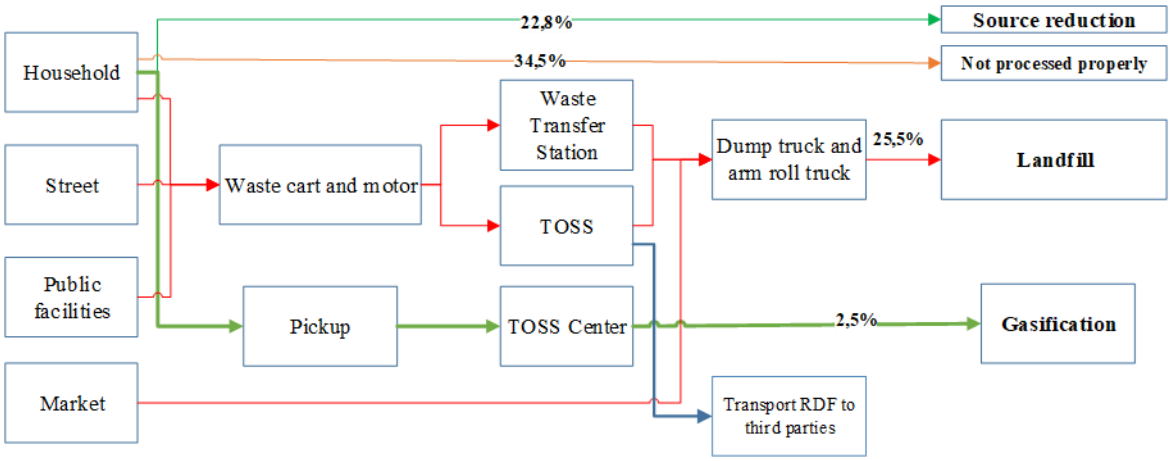

Figure 4. Flow chart of waste management in Klungkung Regency

At the end of 2017, the Government of Klungkung Regency inaugurated the Local Waste Management Program/*Tempat Olah Sampah Setempat* (TOSS). The TOSS program was launched to tackle solid waste generation problems and re-supplying electricity supplies (Suryawan et al., 2021). The TOSS concept's application starts from peuyeumisasi, a natural process involving microbiological anaerobic bacteria to incubate waste that aims to accelerate the decomposition/degradation process. The advantage of peuyeumisasi pretreatment is that it does not require an electricity drying process. Solid waste that has been decomposed through peuyeumisasi then chopped roughly and briquette to be used as pellets. Depending on the use, pellets can be used as stove fuel (LPG substitute) on the housing or as solid waste power plan (PLTSa) fuel. In the power generation line, pellets are then put into a gasification reactor to produce fuel gas (syngas). Syngas is then used as diesel engine fuel to produce electric power. TOSS generated electricity using 15 kW Yanmar diesel Genset and 30 HP Trili on gasifier feeding by pellet (Supriadi Legino et al., 2019). The success of the TOSS program is the significant role of the local government of Klungkung Regency (Supriadi et al., 2019). TOSS Klungkung used 6 tons of pellets per 24 hours running day for generated 40 kW of electricity (Fithri & Fitriani, 2020)v.Pellet can produce in 10 days, and it is faster than bio-coal from agriculture products that need several months (S Legino et al., 2019).

TOSS Center, which has gasification technology, is in TOSS Karangnadi Kusamba Village and can process 9 m^3/day or around 2.5% of the total waste generation in Klungkung Regency (Figure 4). TOSS centres have started operating from the beginning of 2020. TOSS in other villages that function as recycle waste products becomes pellets to send their products to third parties. For pellets sold to steam power plants as co-firing, a plastic weight mixture of 5% - 20% is required. The pellet diameter used for gasification stove needs of 8 mm, size 10 mm for gasifier needs, and size 12 mm for co-firing coal needs in steam power plants.

Since June 12, 2020, the Klungkung Regency government has implemented a policy before transporting waste, which must be source shorting. Solid waste that has been sorted is placed in barrels or baskets wrapped following the composition of waste that the government has determined. The schedule for transporting solid waste can be seen in Table 1. The officer will collect the garbage at 06.00-07.00 WITA and 15.00-16.00 WITA. For building waste and trees, waste must be managed and become the responsibility of the community. What sanctions apply if they do not separate is that waste will not be transported to a landfill or even imprisonment for three months or a maximum fine of Rp. 50,000,000. The regulation is adjusted with the Regional Regulation of Klungkung Regency No. 7 of 2014 concerning waste management.

Table 1. Solid Waste Transportation Schedule in Klungkung Regency Effective June 12, 2020

Tuesday, Wednesday, Thursday, Saturday, Sunday	**Monday and Friday**	**Every day**
Organic Waste	Inorganic Waste	Other Waste
• Food waste • Leaves • Canang	• Plastic • Cans • Paper	• Baby diapers • Sanitary napkins This type of hazardous waste must be wrapped in waterproof and leakproof.

To reduce the amount of waste that will be disposed of the community that produces waste is obliged to process it themselves to be used as fertilizer. Can be processed by composting method with Waste Recycling Pit. Non-organic waste can be recycled, through collectors or waste banks. In addition to this waste must be considered, especially during the COVID-19 pandemic. In the Klungkung area there was a decrease in waste generation during the pandemic. But the waste of masks needs to be considered and must be managed like hazardous waste, its infectious nature (Dhia et al., 2022).

3.3 Solid Waste Management Plan from 2012-2021

Sanitation development requires commitment from all parties and must be done thoughtfully. The seriousness of improving sanitation conditions is contained in the Millennium Development Goals (MDGs), which require increased public access to sanitation facilities in half of the population without access to sanitation. The target of achieving the Millennium Development Goals ends in 2015. However, to date, the achievement of access to drinking water and sanitation is still unsatisfactory concerning the target figures that have been achieved, and the gap still exists. In this regard, the government in the 2015-2019 National Medium-Term Development Plan/Rencana Pembangunan Jangka Menengah Nasional (RPJMN) launched the Universal Access program for the next five years until 2019 (RKPD Kabupaten Klungkung, 2020). Universal Access was initiated by Bappenas and then translated by the Ministry of Public Works through the Directorate General of Human Settlements to respond quickly to Universal Access (Cunningham et al., 2019). Through the 100-0-100, which means achieving 100% access to drinking water, free slums area, and 100% access to

sanitation (Saleh et al., 202. In the waste sector, it is targeted that 80% of urban waste can be managed, and the remaining 20% can be managed in municipal waste reduction facilities through 3R (reduce, reuse, recycle) practices.

Through the Klungkung Regent's Regulation No. 28 of 2019 concerning the 2020 Regional Government Work Plan (SSK Kabupaten Klungkung, 2015), the government will optimize the TOSS program through waste segregation and waste processing technology to produce briquettes and pellets as alternative fuels . It is optimizing the business community's participation as part of stakeholders to play a role and be actively involved in development programs through Corporate Social Responsibility, better known as Corporate Social Responsibility (CSR). The financing of development in the Regency through CSR is seen as potential to be developed by the Klungkung Regency government. An example is the financing of the TOSS program to process waste generation in the Klungkung Regency by CSR from PT. Indonesia Power (Ain et al., 2021).

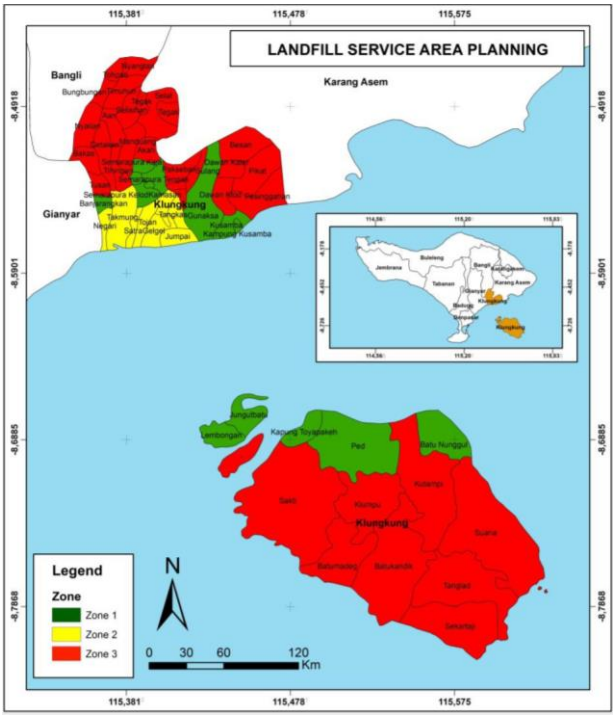

Figure 5. Phase of solid waste development in Klungkung Regency

Conclusion

Solid waste development phases in Klungkung Regency with direct handling in commercial areas with 41% of the existing service coverage served with short-term targets of 45%, medium-term and long-term 50% of the population served. As for indirect handling in rural areas, the existing service coverage is 27.4% of the population served, the short-term target of 35%, medium-term 40% and long-term 50%. The development phase of the Klungkung Regency waste management with direct handling (in the direct) in commercial areas with the scope of existing services 41% served with short-term targets of 45%, medium-term and long-term 50% of the population served. As for indirect handling in rural areas, the existing service coverage is 27.4% of the population served, the short-term target of 35%, medium-term 40% and long-term 50% of the population servedSolid waste development stages include three zones, namely zone I show areas that need to be served 100% (full coverage) in the short term with a direct service system from source to landfill. Zone II, the area that needs to be served by an indirect method, i.e. from households to the Temporary Collection Site (TPS) then to the Final Processing Site (TPA). Zone III, the area that needs to be served in the long term.

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