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RESEARCH ARTICLE

EVALUATION OF SANITARY LANDFILL IN DALAGUETE, CEBU, PHILIPPINES BASED ON NORTHERN TERRITORY ENVIRONMENTAL PROTECTION AUTHORITY

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ABSTRACT

The increased accumulation of solid waste results in severe and extensive problems with waste disposal management. The purpose of this research was to evaluate if the present sanitary landfill in the Municipality of Dalaguete was incompliant with the guidelines based from the Northern Territory Environment Protection Authority (NT EPA, 2013). The study was a descriptive type of research. The study used a questionnaire adopted from NT EPA, given to the Municipal Agriculture and Natural Resources Office (MANRO) staff and workers as the respondent. Statistical tools were used in the analysis of data.

Data shows that 56% of the respondents were aware of the guidelines from Ecological Solid Waste Management Act of 2000 (R.A. 9003) and Municipal Ordinance in the proper waste management. Whereas with regards to the establishment of the sanitary landfill set by the NT EPA (2013), the standard guidelines include: regulation, site selection, landfill design, operation and management, and landfill monitoring. The main problem were the guidelines of: operating and management with 86% compliant, and landfill monitoring with 79% compliant. However, based on the result of the study, the capacity left of the sanitary landfill was approximately 2–5 meters down, since the sanitary landfill was operating since 2003 and it was already in 18 years of operation, and the estimated lifespan of the sanitary landfill based from standard guidelines was up to 20 years. It was recommended that the current sanitary landfill must expand its area of coverage to accommodate the future waste of the Municipality.

KEYWORDS

Environmental problems, operation and management, regulation, site selection, waste disposal management

1. INTRODUCTION

Disposal of solid wastes is a stinging and widespread problem in both urban and rural areas in many developed and developing countries (Abdel-Shafy and Mansour 2018). In 2010, the global solid waste production was estimated to be two billion tons. Most of the developed countries contribute to waste production every year compared to third-world countries (Ozbay, et al., 2021).

In the Philippines, based on the National Solid Waste Management Commission (NSWMC, 2017), the country's calculated waste generation increased from 37,427.46 tons per day in 2012 to 40,087.45 tons in 2016. The composition of municipal solid waste (MSW) in the Philippines were dominated by biodegradable waste, recyclable, residuals and special/hazardous wastes; this classification of waste has been through the municipalities. MSW collection and disposal is one of the major problems of the urban environment. Thus, construction of sanitary landfills for MSW disposal is still going on in many countries. The site selection of the landfill is extremely important due to the lack of public acceptance that results in several social problems (Abdel-Shafy and Mansour 2018). Nonetheless, current and future waste productions require effective landfill use, which varies globally (Ozbay, et al., 2021).

In Cebu City Philippines, the construction of the Inayawan Sanitary Landfill (ISL) represents the city's only final disposal site. However, the waste being disposed of in the landfill had reached its maximum capacity in 2010 (Dickella et al., 2017). In the Municipality of Dalaguete, it also suffered an increase of municipal solid waste (MSW). The Municipal Agriculture and Natural Resources Office (MANRO) established a sanitary landfill in Cansusi, Tapon, Dalaguete as a final disposal site. However, since the establishment of the sanitary landfill, evaluation of the facility has not been assessed. The purpose of the study was to assess the sanitary landfill's level of compliance and suitability to address the proper waste disposal of the community. The result of this study will provide information that could give recommendations on the improvement of the said infrastructure.

2. THEORETICAL BACKGROUND

The Zero Waste Theory has been proposed and used in this study. According to PHD chemist Paul Palmer introduced Zero Waste in the 1970s the theory is semi- philosophical because reaching 0% in waste management is not possible as there is always a residue. This thesis aims to point out the factors that might be overseen during waste management concerning its risks to present and future. Moreover, this established a concept about waste and its types and also described the management systems and legislations. Finally, landfill construction science has advanced significantly since the days when waste was dumped in open, unlined "dumps". Today, modern landfills like High Acres are carefully designed to contain waste while also protecting the environmental integrity of the surrounding area, including the air, water, and soil (Upadhyaya, 2013).

Effective waste management is a high priority in the NT EPA (2013), the

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siting, design and management of landfills play an integral role in waste disposal. Guidelines have been written to provide guidance and should be used for the planning of environmental approvals and licensing for new landfill sites and expansion of existing landfill sites. It also

applies to existing landfill sites in the operation and management of sanitary landfill: Regulation, Site Selection, Landfill Design, Operation and Management, and Landfill Monitoring.

In coordination with, the Ecological Solid Waste Management Act of 2000 or (R.A. 9003) is an act providing for an ecological solid waste management program. The implementation and enforcement of waste management facilities criteria for siting, establishment and operation of sanitary landfill. In coordination with various LGU departments, the Municipal Agriculture and Natural Resources Office (MANRO) and Municipal Planning Office (MPO) jointly implements permitting procedures for wastes management facilities, the Municipal Ordinance No. 99-39 proceeding for a Comprehensive Solid Waste Management Program and created for Dalaguete Solid Waste Management Program (DSWMP) as a vehicle for a municipal system of management of waste from collection to its disposal.

The proposal contains the recommendations for the sanitary landfill in the Municipality of Dalaguete.

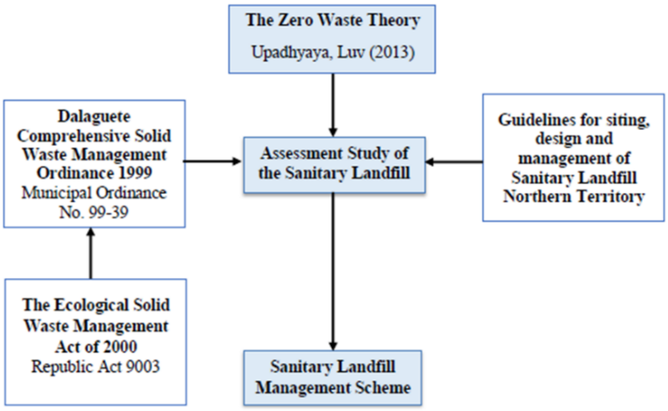

Figure 1: Theoretical Framework

3. METHODOLOGY

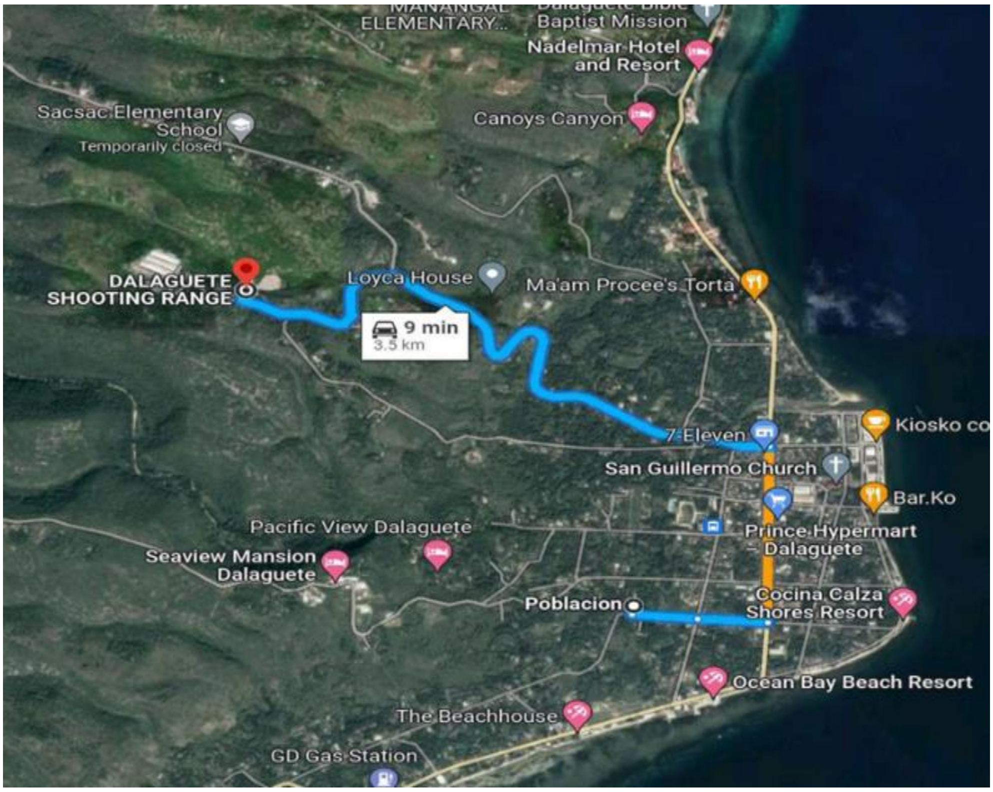

Figure 2: Map of the Study (Google)

The study was conducted in the Municipality of Dalaguete, 109 kilometers from Cebu City (coordinates). The Municipality of Dalaguete has a sanitary landfill located 3 kilometers outside of Población Dalaguete. It was specifically located in Cansusi, Tapon, Dalaguete. Since the establishment of the facility the set-up has not been assessed whether it has passed the standard guidelines from R.A. 9003 and also from other countries' standards.

The study utilized two sets of questionnaires in the form of checklists. The first set of questionnaires was adopted from R.A 9003 and Municipal Ordinance No. 99-39 that deals with the awareness of the workers about the implementation of the guidelines in the establishment of the sanitary landfills. The second set of questionnaires was adopted from NT EPA (2013) that deals on the guidelines of sitting, design and management of sanitary landfills. The identified respondents include the MANRO Staff (7) and the Worker in the site (1).

Statistical tools were used in the analysis of data. These tools include the qualitative analysis that interprets information from the non-numerical data. The quantitative analysis explained the numerical figures of the checklist.

4. RESULT

4.1 Description of the Sanitary Landfill

This provides the information which identifies the area measurements, list of waste generated and sources of waste of Sanitary Landfill in the Municipality of Dalaguete.

4.1.1 Layout of Sanitary Landfill

The Dalaguete Solid Waste Management Program (DSWMP) has a total area of 2.2 hectares. This consisted of a vermicomposting facility, plant nursery, shooting range, waste recovery facility, and the sanitary landfill. Specifically, the waste recovery facility with a total dimension of 5,000 square meters, and the sanitary landfill with 0.8 hectares were to address the waste disposal management of the municipality. With the said area of the sanitary landfill it can hold up to approximately 65,000 cubic tons and has an estimation of 15 years life span and more.

4.1.2 List of Waste Generated

Table 1 shows the different types of wastes that were generated in the sanitary landfill. These wastes were categorized as biodegradable, recyclable residuals and special wastes. As to the result of the study it was point-out that the waste generated within five (5) years from 2017- 2021 were found to be in increasing trend. The most waste generated was the biodegradable waste with 56% kg/year, followed by recyclables with 25%, next was the residual with 14% and for special wastes with 4% kg/year. The special wastes include all types of medical wastes coming from hospitals and health centers. This implies that the municipality was ineffective on proper waste management, hence the supply of the generated waste was increasing.

The result of the study was similar to the findings of National Solid Waste Management Commission (NSWMC, 2017) wherein the majority of the waste collected was also coming from biodegradables with 52%, followed by recyclables with 28 %, residuals with 18% and special/hazardous waste with 2% generation. In addition, in India, majority of the wastes was also generated from biodegradable or organic (41 wt.%) and from potentially recyclable wastes (19 wt.%) (Kumar, et al., 2017).

However, in this study the Municipality of Dalaguete has started to develop a technology of recycling their waste and converting them into organic fertilizers. These organic fertilizers were sold to vegetable farmers in different barangays within the municipality in compliance with the implementation of the guidelines as stipulated in R.A. 9003.

Table 1: List of Waste Generaed

List of Waste Generated (kg) based on WACS							
Year	Projected Population	Waste Gen/ Capita/ day	Daily Waste Generated	Bio (55.82%)	Recyclable (25.24%)	Total Residual Waste (14.19%)	Special (4.10%)
2017 (Base Year)	69,127	0.4384	30,303.74	16,915.55	7,648.66	4,300.10	1,242.45
2018	69,956	0.4442	31,077.94	17,347.71	7,844.07	4,409.96	1,274.20
2019	70,796	0.4506	31,898.10	17,805.52	8,051.08	4,526.34	1,307.82
2020	71,645	0.4574	32,768.05	18,291.13	8,270.66	4,649.79	1,343.49
2021	72,505	0.4647	33,691.95	18,806.85	8,503.85	4,780.89	1,381.37

4.1.3 Sources of Waste

Table 2 represents that the sources of waste in the municipality were divided into four (4) sectors; residential (urban and rural), commercial (food establishments, general stores, public market, service centers), institutions (offices, schools, finance) and recreational (resort). These sources of waste increase within five (5) years from 2017-2021. The majority of waste was generated in residential areas with 82%, followed by commercial areas with 12%, next was in institutions with 4% and recreational areas with 2%. The findings reveal that residential areas were unaware of the amount of garbage they generated each year and that unregulated waste creation had an impact on waste disposal management. Nevertheless, the municipality has the proper collection of garbage weekly from Monday-Saturday within barangays and special requested areas.

The result of the study was confirmed from the findings of National Solid Waste Management Commission (NSWMC, 2017) that majority of the waste was generated from residential with 57%, commercial sources with 27%, institutional with 12%, and 4% percent waste coming from the industrial sector. In addition, according to Letshwenyo, et al., (2020), that in Palapye, a town in Botswana, majority of the waste was generated from both of household and commercial.

Table 2: Sources of Waste

Major Sources of Waste						
		2017	2018	2019	2020	2021
Major Sources	%	30303.74	31,077.94	31,898.10	32,768.05	33,691.95
Residential	82.48%	24994.52	25633.08	26309.55	27027.09	27789.12
Urban	27.58%	8357.77	8571.30	8797.50	9037.43	9292.24
Rural	54.90%	16636.75	17061.79	17512.06	17989.66	18496.88
Commercial	11.62%	3521.29	3611.26	3706.56	3807.65	3915.00
Food Establishments	0.83%	251.52	257.95	264.75	271.97	279.64
General Stores	5.05%	1530.34	1569.44	1610.85	1654.79	1701.44
Public Market	5.69%	1724.28	1768.33	1815.00	1864.50	1917.07
Service Centers	0.05%	15.15	15.54	15.95	16.38	16.85
Institutions	4.01%	1215.18	1246.23	1279.11	1314.00	1351.05
Offices	0.34%	103.03	105.66	108.45	111.41	114.55
Schools	3.49%	1057.60	1084.62	1113.24	1143.60	1175.85
Finance	0.17%	51.52	52.83	54.23	55.71	57.28
Recreational	1.89%	572.74	587.37	602.87	619.32	636.78
Resort	1.89%	572.74	587.37	602.87	619.32	636.78

4.2 MANRO Staff and Workers level of awareness in compliance as to National and Local ordinances

In table 3, it shows that 44% of workers are fully aware of the national and local ordinances implemented, 56% are just being aware and none of them are unaware of the said policy. This implies that the municipality has conducted training and seminars to their staff and workers with regards to the different guidelines as stipulated in R.A. 9003 in the establishment of the sanitary landfill. In addition, the established sanitary landfill of the municipality was based on national policy and approved ordinances. Under R.A. 9003, section 37 which prohibits the operation of open dumpsite but rather the establishment of sanitary landfill. Dickella et al., (2017) emphasized that the sanitary landfill was constructed in Inayawan, Cebu, Philippines. However, it was instructed to be permanently cease and desist from dumping of waste, due to not complying the guidelines under R.A. 9003. As a result, the sanitary landfill was permanently closed. The same situation was happened in the city of Naga wherein the Balatas Dumpsite with a total area of 16,978 m2 or 1.7 hectares was closed for not following the guidelines of R.A. 9003 (NEXUS 2017).

Table 3: Awareness Checklist

	RATINGS		
ACTS/ ORDINANCE	Fully Aware (3)	Aware (2)	Not Aware (1)
Ecological Solid Waste Management Act of 2000 or Republic Act 9003	50%	50%	0
Dalaguete Comprehensive Solid Waste Management Ordinance 1999 Municipal Ordinance No. 99-39	38%	62.5%	0
TOTAL	**44%**	**56%**	**0**

4.3 Guidelines for the Siting, Design and Management of Sanitary Landfill

The Landfill Compliance Checklist was adopted and modified from Northern Territory Environment Protection Authority's Guidelines for Siting, Design and Management of Solid Waste Disposal Sites. The sanitary landfills' in- charge-personnel of the regulation, site selection, landfill design, operation and management, and landfill monitoring responded to the survey questionnaire.

4.3.1 Regulation

The Landfill Compliance Checklist was adopted and modified from Northern Territory Environment Protection Authority's (NTEPA 2013). The sanitary landfills' in-charge-personnel of the regulation, site selection, landfill design, operation and management, and landfill monitoring serve as the respondent of the study.

Table 4 shows the regulatory requirements associated with planning and operation of sanitary landfills. The guidelines include the approvals and licenses of the following: Business Permits and Licensing Office (BPLO), and Rural Health Unit (RHU). Upon complying and seeking the following requirements, the Dalaguete Solid Waste Management Program (DSWMP) was 100% compliant. The result implies that sanitary landfill of the municipality was safety of any harm that could affect the health of the nearby community. In addition, the sanitary landfill could operate businesses like selling organic fertilizer to the community since they were certified by the Rural Health Unit as well as from BPLO.

The result of the study furtherly implies that the sanitary landfill can operate for a longer period of time. In the Philippines, as an alternative, the construction of sanitary landfill (SLF) was allowed as a final disposal site for residual waste but it should be in accordance with the criteria provided by the act Section 40,41 and 42 (Atienza, 2011).

Table 4: Regulation

Regulation		
Guidelines (NT EPA, 2013)	**Yes**	**No**
1. Approvals/Licenses	100%	0%
Total	**100%**	**0%**

4.3.2 Site Selection

Table 5 represents the guidelines on site selection. This focused on the (1) strategic waste management, (2) site selection process and (3) site selection criteria (NT EPA 2013). The result shows that they were 96% compliant and 4% noncompliant of the guidelines. Both site selection (2) process and (3) criteria were 100% compliant and none were incompliant. While in (1) strategic waste management was 88% compliant and 13% incompliant. The factor affecting the strategic waste management was on the sanitary landfill site size required to meet current and future disposal requirements. This implies that on the proximity to communities in which the sanitary landfill rendered its services, as stipulated in table 1, the amount of waste generated from the municipality was increasing. In this study states that the sanitary landfill has only 0.8 hectares and the capacity was insufficient for future use due to smaller area in coverage.

For the selection of the site, preference should be given to places where the operations of the sanitary landfill will lead to an improvement in the terrain; this will greatly reduce any possibility of operational problems in the future. Only very rarely will a terrain meet all the ideal requirements for the construction of a sanitary landfill (Jaramillo, 2003). However, one of the most difficult steps was locating sanitary landfill locations. Considering that, including the distance from the river, the distance from the fault, and the distance from the road, the waste landfill sites must be accepted by the people (Safavian, et al., 2015).

Table 5: Site Selection

Site Selection		
Guidelines (NT EPA, 2013)	**Yes**	**No**
1. Strategic Waste Management	88%	13%
2. Site Selection Process	100%	0%
3. Site Selection Criteria	100%	0%
Total	**96%**	**4%**

4.3.3 Landfill Design

Table 6: Sanitary Landfill Design

Sanitary Landfill Design		
Guidelines (NT EPA, 2013)	**Yes**	**No**
1. Design Consideration	73%	27%
2. Groundwater Management and Control	100%	0%
3. Surface Water and Stormwater Management	67%	33%
4. Leachate Generation and Characteristics	100%	0%
5. Leachate Retention and Liner Systems	100%	0%
6. Leachate Collection and Removal Systems	100%	0%
7. Leachate Recirculation	100%	0%
8. Leachate Treatment and Disposal	100%	0%
9. Landfill Gas Management	100%	0%
10. Construction Quality Assurance	100%	0%
11. Closure and Post Closure Plans	100%	0%
Total	**95%**	**5%**

Table 6 shows the guidelines on landfill design. This comprised of (1) design consideration, (2) groundwater management and control, (3) surface water and stormwater management, (4) leachate generation and characteristics, (5) leachate retention and liner systems, (6) leachate collection and removal systems, (7) leachate recirculation, (8) leachate treatment and disposal, (9) landfill gas management, (10) construction quality assurance, (11) closure and post closure plans. With the result obtained, landfill design has an average total of 95% compliant and 5% incompliant. The following guidelines of: (2) groundwater management and control, (4) leachate generation and characteristics, (5) leachate retention and liner systems, (6) leachate collection and removal systems, (7) leachate recirculation, (8) leachate treatment and disposal, (9) landfill gas management, (10) construction quality assurance, (11) closure and post closure plans found to be 100% compliant and non were incompliant. While the guidelines of: (1) design consideration results with 73% compliant and 27% incompliant, and (3) surface water and stormwater management with 67% compliant and 33% incompliant (NT EPA, 2013).

The guidelines that were ineffective as to (1) design consideration, and (3) surface water and stormwater management were: (1) area method that was best suited for flat to gently sloping areas where design and operation will be simplified. And a well suited to high rainfall or high groundwater conditions, trench method, staging of site development, waste tires are individually treated with larvicide, the method of final reinstatement and (3) final uses for the site and discharge to water. This implies that the DSWMP has the unavailability of some variables with regards to establishing the proper design of sanitary landfill.

The topography of the terrain, as well as the kind of soil and the depth of the water table, determine the construction procedures and subsequent operation of a sanitary landfill. In generally flat settings were digging pits or trenches to bury garbage may be impractical, waste might be dumped directly on the original ground, which should be raised several meters after the landscape has been made waterproof (Jaramillo, 2003). However, In the Philippines, the construction of a sanitary landfill was one of the solid waste management solutions used to reduce health-related issues and the impact on wildlife and marine organisms. Nonetheless, based on DENR guidelines via DAO 1998-50, there are some criteria for determining acceptable sites for the creation of sanitary landfills. Land use, road, slope, river, groundwater, critical biodiversity/protected areas, land cover, groundwater, soil, erosion susceptibility, cultural sites, settlements/built-up areas, and faults are among the characteristics considered (Buncag, Ph.D 2020).

4.3.4 Operation and Management

Table 7: Operation and Management

Operation and Management Guidelines (NT EPA, 2013)	Yes	No
1. Environmental Management	100%	0%
2. Financial Assurance	100%	0%
3. Waste Minimization	100%	0%
4. Waste Acceptance	83%	17%
5. Waste Pre-treatment	100%	0%
6. Waste Placement	100%	0%
7. Waste Compaction	33%	66%
8. Cover	67%	33%
9. Staff and Training	100%	0%
10. Health and Safety	100%	0%
11. Site Access	100%	0%
12. Roads	100%	0%
13. Visual Amenity	100%	0%
14. Nuisance Control	67%	33%
15. Fire Prevention and Management	100%	0%
16. Water Management	100%	0%
17. Closure and Post Closure	20%	80%
Total	86%	13%

In table 7 represents the guidelines on operation and management. The guideline includes of: (1) environmental management, (2) financial assurance, (3) waste minimization, (4) waste acceptance, (5) waste pre-treatment, (6) waste placement, (7) waste compaction, (8) cover, (9) staff and training, (10) health and safety, (11) site access, (12) roads, (13) visual amenity, (14) nuisance control, (15) fire prevention and management, (16) water management, (17) closure and post closure. The result shows that the guidelines have an average total of 86% compliant and 13% incompliant. The following guidelines of: (1) environmental management, (2) financial assurance, (3) waste minimization, (5) waste pre- treatment, (6) waste placement, (9) staff and training, (10) health and safety, (11) site access, (12) roads, (13) visual amenity, (15) fire prevention and management, and (16) water management were 100% compliant and non were incompliant. The (3)waste acceptance was 83% compliant and 17% incompliant. In both (8) cover and (14) nuisance control was 67% compliant and 33% incompliant. The (7) waste compaction acquired 33% compliant and 66% incompliant. And the (17) closure and post closure with 20% compliant and 80% incompliant. daily cover, nuisance control and environmental monitoring (NT EPA, 2013).

The guidelines that were ineffective as to (4) waste acceptance, (8) cover,(14) nuisance control, (7) waste compaction, and (17) closure and post closure were: (4) waste acceptance criteria where the types of waste that a facility is capable of receiving were dependent on the site location and waste acceptance criteria for listed wastes, (8) cover requirements specifically daily cover, (14) landfill operator for effective litter control, dust generation on site, odor control, minimize the attraction of birds, reduce the nuisance and risk to health associated with mosquitoes and other biting insects, (7) site preparation requirements, waste density and operator comfort and safety, (17) rehabilitation plan, future use plan, settlement and final surface profile, after-care which includes environmental monitoring. This signifies that the in-charge personnel were not able to fully practice the operation and management of the sanitary landfill. The absences of those parameters were a basis that DSWMP needs to address in order for them to be fully compliant.

Understanding how landfill managers and operators see things will help us identify the issues that need to be solved first in order to improve MSW management and promote more ethical and sustainable waste disposal methods (Latocheski, et.al., 2021). On their study of Brazilian landfills, they comprehended the viewpoints of the managers and operators of the two landfills in Curitiba and its Metropolitan Area, which were in charge of disposing of the trash generated by 23 municipalities.

4.3.5 Sanitary Landfill Monitoring

Table 8 shows the guidelines on landfill monitoring. The guidelines include the following: (1) groundwater monitoring, (2) leachate monitoring, (3) surface water monitoring, (4) landfill gas monitoring and (5) analysis and review of monitoring data. The result verifies that the guidelines have an average total of 79% compliant and 21% incompliant. The guideline on (1) ground water monitoring obtained 100% compliant and none were incompliant. In both (3) surface water monitoring and (4) landfill gas monitoring obtained 90% compliant and 10% incompliant. The (5) analysis and review of monitoring data with 67% compliant and 33%. While the (2) leachate monitoring was 50% compliant and 50% (NT EPA, 2013).

The guidelines that were ineffective as to (3) surface water monitoring, (4) landfill gas monitoring, (5) analysis and review of monitoring data, and (2) leachate monitoring were: (3) parameters for surface water quality monitoring, (4) monitoring for the following parameters, (5) analytical methods applied to the data: purpose of the analysis, form, precision and spread of data, validity of method and its professional acceptance, form and ease of interpretation of the results, (2) leachate monitoring on regular measurement , determination, and on its monitoring changes. This implies that the DSWMP was negligent in its monitoring of the aforementioned sanitary landfill.

According to the Journal of Material Cycles and Waste Management issue (2017), an important turning point in Indonesian waste management policy, particularly with regard to landfill operation and management, was the passage of the Waste Act in 2008. According to the law, landfill owners must close any open dumps and replace them with brand-new, environmentally responsible landfills (Munawar, et. al, 2017). However, as to Van Ryan Kristopher R. Galarpe (2014) in his Review on The Impacts of Waste Disposal Sites in the Philippines, the review emphasized the current state of SW disposal sites in the Philippines in a qualitative way. Therefore, it can be deduced that potential environmental contamination from disposal sites can show up in the groundwater, soil, air, plants, and scavenging animals nearby. The nearby community may also be harmed, endangering their own health. There was probably a high prevalence of dengue, upper respiratory, cutaneous, and gastrointestinal illnesses. Notwithstanding the potential health dangers associated with disposal sites, communities frequently opt for the available options due to a perception of economic dependence on available jobs and resources. In order to effectively carry out the requirements of RA 9003, local government entities must take into account the economic potential, health, and environment of neighboring communities (https://link.springer.com/article/10.1007/s10163-017-0676-3: https://www.researchgate.net/profile/Van-Ryan-Kristopher-Galarpe-2/publication/316598058).

Table 8: Sanitary Landfill Monitoring

Sanitary Landfill Monitoring		
Guidelines (NT EPA, 2013)	**Yes**	**No**
1. Groundwater Monitoring	100%	0%
2. Leachate Monitoring	50%	50%
3. Surface Water Monitoring	90%	10%
4. Landfill Gas Monitoring	90%	10%
5. Analysis and Review of Monitoring Data	67%	33%
Total	**79%**	**21%**

4.4 Level of Compliance of The Sanitary Landfill in The Municipality of Dalaguete

The main focus was to assess the variables on the operating and management (table 7), and landfill monitoring (table 8). The results in operating and management guidelines (table 7) with an average total of 86% compliant and 13% incompliant, and landfill monitoring (table 8) with 79% compliant and 21% noncompliant affects the level of compliance of the sanitary landfill (NT EPA, 2013). It was found that various elements were not completely practiced and properly monitored in accordance with the guidelines' criteria.

Furthermore, the guidelines that were ineffective identified to be developing concern with the landfill's capacity. Considering that the estimated lifespan of sanitary landfills based on standard guidelines was up to 20 years, and that the sanitary landfill of the Municipality of Dalaguete has been in operation for almost a decade and eight years, since 2003. This implies that around 2-5 meters of projected dumping capacity remained, this results in its peak of closing.

According to Ghana Mining Journal, the location of a landfill in any environment is an important issue that needs to be taken into account because of a number of variables, including the landfill's lifespan, site selection, design, construction, operation, and management. In order to investigate the risk involved in obtaining new lands for landfills, it is crucial to precisely predict the duration of the landfill. Also, an appropriate methodology for predicting the lifespan of landfills must be taken into account. In a study at the Aboso landfill in Tarkwa, Ghana, it was determined how long the landfill would last using the future value of money equation. The outcome indicated that the landfill may continue to function for another twelve years before its useful life was out (Akyen et. al, 2017). Moreover, as the Environmental Management Bureau (EMB-DENR) issued a Resolution No. 64, Series of 2013 stating that a sanitary landfill has at least 10 years of operation before it closes (https:// www.ajol.info/index.php/gm/article/view/164062:https://nswmc.emb.gov.ph/wp-content/uploads/2016/07/nswmc-reso-64-adoption-of-modified-guideline-on-site-identifcation-criteria-SLF.pdf).

5. Discussion

With the given data and corresponding results, the main problem of the sanitary landfill with regards to the guidelines were the: operating and management that was 86% compliant, and landfill monitoring which was 79% was beyond compliant. These concerns required absolute attention aiming to fulfill the gaps based on the sanitary landfill guidelines adopted from NT EPA (2013). This serves as the basis for DSWMP as what needed to be addressed in order for them to be fully compliant. The researchers subsequently provided the following recommendations to specifically meet current and future needs of siting, design and management of sanitary landfill. In line with the study's findings the Sanitary Landfill Management Scheme has been proposed (Appendix 1). It contains recommendations which result in the expansion of the sanitary landfill's area of coverage to accommodate the future waste of the Municipality. This aimed to provide the framework and served as guidelines for improvement of the management and mitigation of the said disposal site.

Overall, effective waste management is a high priority in the Northern Territory, and landfill siting, design, and management are critical components of sustainable waste management. The primary goal is to conserve resources through effective resource avoidance and recovery, with landfills playing an essential role as part of the transfer necessary to achieve sustainable resource recovery and waste management—the zero-waste idea. Landfills' primary function is to receive remaining materials that cannot be avoided, reduced, reused, recycled, or recovered (NT EPA, 2013).

5. Conclusion

The sanitary landfill of Municipality of Dalaguete was still compliant as to the standard guidelines and the necessary requirement upon sitting, designing, operating and managing a sanitary landfill, somehow it was affected with the main problem under operating and management, and the landfill monitoring. Concluded the sanitary landfill was operating since 2023 and the capacity remaining of the sanitary landfill is approximately 2-5 meters down, therefore can operate for the remaining 3-5 years. However, could prolong a landfill's time span if the proposed Sanitary Landfill Management Scheme will be approved and implemented.

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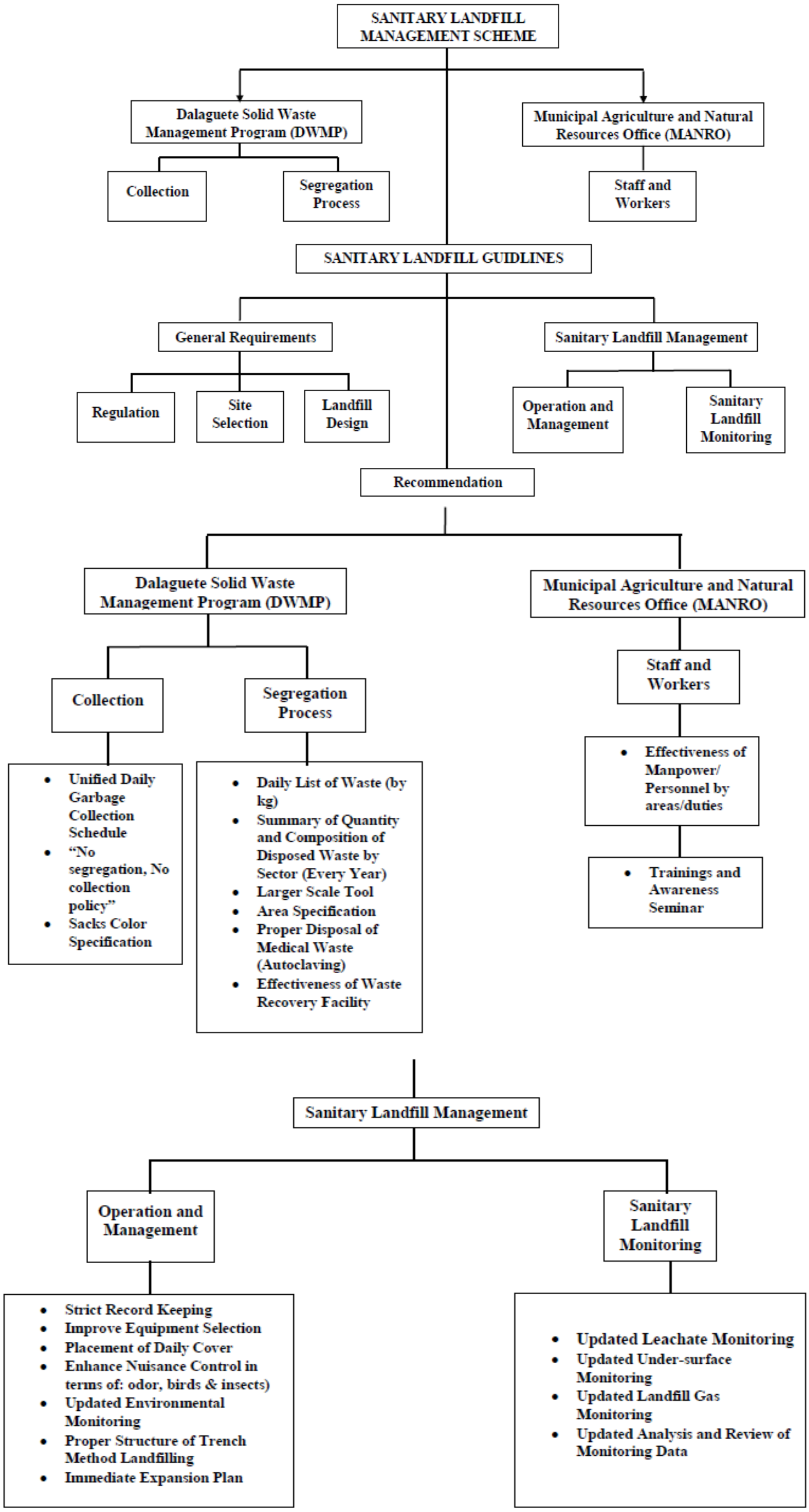
SANITARY LANDFILL MANAGEMENT SCHEME
Dalaguete Solid Waste Management Program (DWMP)
Municipal Agriculture and Natural Resources Office (MANRO)
Collection
Segregation Process
Staff and Workers
SANITARY LANDFILL GUIDLINES
General Requirements
Sanitary Landfill Management
Regulation
Site Selection
Landfill Design
Operation and Management
Sanitary Landfill Monitoring
Recommendation
Dalaguete Solid Waste Management Program (DWMP)
Municipal Agriculture and Natural Resources Office (MANRO)
Collection
Segregation Process
Staff and Workers
Unified Daily Garbage Collection Schedule
"No segregation, No collection policy"
Sacks Color Specification
Daily List of Waste (by kg)
Summary of Quantity and Composition of Disposed Waste by Sector (Every Year)
Larger Scale Tool
Area Specification
Proper Disposal of Medical Waste (Autoclaving)
Effectiveness of Waste Recovery Facility
Effectiveness of Manpower/ Personnel by areas/duties
Trainings and Awareness Seminar
Sanitary Landfill Management
Operation and Management
Sanitary Landfill Monitoring
Strict Record Keeping
Improve Equipment Selection
Placement of Daily Cover
Enhance Nuisance Control in terms of: odor, birds & insects)
Updated Environmental Monitoring
Proper Structure of Trench Method Landfilling
Immediate Expansion Plan
Updated Leachate Monitoring
Updated Under-surface Monitoring
Updated Landfill Gas Monitoring
Updated Analysis and Review of Monitoring Data