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ASSESSMENT OF PROPER INDUSTRIAL WASTE DISPOSAL AT LANDFILL SITES AND MONITORING OF SELECTED DUMPING SITES IN THE PROVINCES OF SOUTH AFRICA

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Abstract

. Waste is buried at landfill sites as a method of disposal. Various waste kinds are accepted by general dump sites, including building and garden trash, commercial and non-hazardous industrial waste, and domestic waste. South Africa particularly Mpumalanga Province has a high unemployment rate especially women and youth and a lack of finances is experienced by many members of the communities, especially in rural areas. Data on the state of the landfill, and types of waste generated that have the potential to be recycled, were recorded to assess if recycling could be increased to relieve the economic burden of the poor communities. Attention was paid to the following aspects: assessing the current status of each landfill and identifying the types of waste generated in the area that ended up at the landfills. The extent of recycling and the waste handling and disposal of the waste were recorded. Non-compliance with the prescribed legislative guidelines was noted and aspects such as the state of the landfills and noncompliance of industrial waste were also observed and proper enclosure, recycling, and products being recycled were identified and recorded. The waste disposal practices at most landfills were poor and very limited recycling was taking place. None of the landfills in the province complied with the minimum requirements for landfilling. Recommendations to improve waste disposal and identification of products with recycling potential were made. Alternative waste strategies which could be economically beneficial. Effective management of waste and the promotion and management of recycling activities are necessary for sustainable and liveable cities. This article aims to describe the approaches used on 6 landfills in South Africa to manage waste pickers' access to recyclables and their daily activities on the landfills. A multiple-case study design and cross-case analysis were used in this study.

Keywords: Landfill site, recycle, livelihood, sustainable

INTRODUCTION

Waste products are disposed of at a landfill site, sometimes referred to as a tip, dump, rubbish dump, garbage dump, trash dump, or dumping ground. Although the systematic burying of garbage with daily, intermediate, and ultimate covers only started in the 1940s, landfills are the oldest and most popular place to dispose of waste. Historically, trash was merely piled up or dumped into pits; this is referred to as a midden in archaeology and updated following a rise in pollution. Various phases of waste material processing, including sorting, treatment, and recycling, as well as waste management functions like temporary storage, consolidation, and transfer, are carried out at these dump sites. Lithification of the ground or intense shaking during an earthquake can occur in landfills if they are not stabilized. Land over a landfill can be reclaimed for uses other than disposal once it is filled.

Building sustainable cities requires effective trash management. The World Bank states that improving solid waste management is essential since waste generation is accelerating and will double by 2025 (Hoornweg et al., 2013; World Bank, 2016). Currently, 1.3 billion tons of trash are produced every year worldwide; by 2025, that amount is predicted to rise to 2.2 billion tonnes (World Bank, 2016). Several developing nations still struggle to dispose of waste produced, in contrast to developed nations with sophisticated waste management practices. This is primarily because it puts a strain on municipal budgets and the officials in charge of waste management lack the necessary knowledge and expertise (Fergutz et al., 2011; Guerrero et al., 2013).

The 15th-highest amount of garbage produced worldwide, 54.425 tons, is produced daily in South Africa (World Bank, 2016). In South Africa in 2011, just about ten percent of garbage was recycled, according to the Department of Environmental Affairs (DEA). (DEA, 2012) The remaining, unrecycled material (98 million tons) was dumped in landfills. It follows that the fast depletion of landfill capacity in South Africa is not shocking (Chvatal & Smit, 2015). The South African government developed the National Waste Management Strategy in 1998 to provide an integrated waste management solution. According to the Municipal Systems Act (Act 32, 2000), local governments are in charge of managing landfills. Three key components make up the waste management strategy: reduce (waste minimization), reuse, and recycle (Garner, 2009; Chvatal & de Smit, 2015).

This study's objectives included documenting details about each landfill's structure, services offered, Identification of Invasive species plants in each landfilled and the best possible methods to control the spread, to check if industrial waste collected for manufacturing or recycled product types are done properly, and the existence of waste pickers, and Health and safety risks identification within the land, number of job creation and mitigation of such risk.

Although there aren't many obstacles to getting started in informal waste picking, there are still obstacles that prevent waste pickers from accessing, collecting, and selling recyclable waste (Viljoen, 2014). Municipal waste management plans need to include inclusive policies and practices for waste pickers. Almost all

human action, no matter where in the world, produces waste. The population's economic growth and improved social conditions have boosted garbage generation both locally and globally, adding to the waste burden. Activities in the urban, municipal, and industrial sectors produce waste (Rapti-Cuputo, Sdao, and Masi, 2006).

Literature Review

According to Onu (2000), ineffective waste collection methods, uneven or insufficient service delivery because of financial limitations, careless dumping, a lack of environmental control systems, littering, and scavenging all contribute to the problems with solid waste management in developing nations. One of the most significant factors about the state of waste management services was found to be the general public's lack of understanding regarding waste and environmental awareness. Uncontrolled landfilling methods and issues with solid waste disposal have been linked to environmental and public health issues, according to an Indian study (Ray, Roychoudhury, Mukherjee, Roy, and Lahiri, 2005). Landfilling is the typical method used to dispose of municipal solid waste (Cotman and Gotvajn, 2010).

Regulations for waste management

It was projected in 2000 that more than 2 billion tons of municipal solid garbage would be produced annually, according to Guisti (2009). The Environmental Conservation Act (ECA) and the National Water Act (1998) provide two legally recognized definitions of waste in South Africa. (Godfrey and Olofse, 2008). The Department of Water Affairs' Minimum Requirements for Trash Disposal by Landfill (DWAF, 1998) governs the disposal of trash in landfills. The Environmental Conservation Act, 1989 (Act 73 of 1989) has Section 20(1) on landfill permitting conditions, which regulate and legally enforce the standards. The National Waste Management Strategy (NWMS), which was approved by the Cabinet on November 9, 2011 (Department of Environmental Affairs, 2011), promulgates and recommends all of these factors, which are part of the waste hierarchy: Waste minimization or avoidance, which aims to reduce or eliminate waste; Reuse, which involves using waste without reprocessing; Recycling, which involves turning material into new products; Composting, which improves soil through composting; and Disposal, which consists of disposing of waste residues at authorized landfill

Status of Alien Invasive Plants in Landfill Sites

During the survey, we noticed that all landfill sites were invaded with different categories of alien invasive plants. Alien invasive plants are plants coming from other countries to outcompete our native plants. They are categorised into four namely: Category 1a, Category 1b, Category 2 & Category 3. The following list of the species was observed and recorded in the landfill site: Category 1b: *Lantana Camara*, *Tecoma stans*, *Solanum mauritianum*, *Melia azedarach*, *Ricinus communis* they were the most dominant well-established weeds in all the landfill sites

. In six dumping sites was observed that plants were dumped everywhere except in one landfill site where garden rubbish that includes alien invasive plants was put in a pit and burnt down. Burning is one of the recommended methods of managing the biological invasion. Management of alien invasive plants in the landfill site is a serious challenge and requires urgent intervention and this increases serious negative impact on biodiversity and climate change

Table 2:List of species Observed and recorded in the 5 landfill sites

scientific name	ListStatus	OccurenceStatus
<i>Aristolochia elegans</i> Mast.	1b	Present
<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	1b	Present
<i>Ipomoea alba</i> L.	1b	Present
<i>Lantana Camara</i> L.	1b	Present
<i>Melia azedarach</i> L.	1b	Present
<i>Ricinus communis</i> L.	2	Present
<i>Selenicereus undatus</i> Haw. & D.R.Hunt	1b	Present
<i>Senna didymobotrya</i> (Fresen.) H.S.Irwin & Barneby	1b	Present
<i>Senna septemtrionalis</i> (Viv.) H.S.Irwin & Barneby	1b	Present
<i>Solanum mauritianum</i> Scop.	1b	Present
<i>Sphagneticola trilobata</i> (L.) Pruski	1b	Present
<i>Tithonia diversifolia</i> (Hemsl.) A.Gray	1b	Present
<i>Manihot grahamii</i> Hook.	NotListed	Present
<i>Canna indica</i> L.	1b	Present
<i>Anredera cordifolia</i> (Ten.) Steenis	1b	Present
<i>Macroptilium atropurpureum</i> (DC.) Urb.	SUSPECTS	Present
<i>Desmodium uncinatum</i> (Jacq.) DC.	SUSPECTS	Present
<i>Passiflora suberosa</i> L.	1b	Present
<i>Mirabilis jalapa</i> L.	1b	Present
<i>Passiflora subplate</i> Ortega	1b	Present
<i>Tithonia rotundifolia</i> (Mill.) S.F.Blake	1b	Present
<i>Tecoma stans</i> (L.) Juss. ex Kunth	1b	Present
<i>Leucaena leucocephala</i> (Lam.) de Wit	2	Present
<i>Solanum seaforthianum</i> Andrews	1b	Present
<i>Ageratum conyzoides</i> L.	1b	Present
<i>Sesbania punicea</i> (Cav.) Benth.	1b	Present

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<i>Morus alba L.</i>	3	Present
<i>Heliotropium amplexicaule Vahl</i>	NotListed	Present
<i>Bougainvillea glabra Choisy</i>	NotListed	Present
<i>Senna occidentalis (L.)</i>	1b	Present
<i>Ricinus communis L.</i>	2	Present
<i>Senna didymobotrya (Fresen.) H.S.Irwin & Barneby</i>	1b	Present
<i>Datura ferox L.</i>	1b	Present

Landfill operation in Hawaii

In the fiscal year 2022, businesses and individuals of Hawaii Island produced 203,872 tons of garbage. That waste was largely disposed of in landfills. Nonetheless, the County kept roughly 50,646 tons of that garbage out of the landfill. Compostable green trash (36,363 tons) and scrap metal (10,098 tons) accounted for the majority of the diverted waste. Paper (2,358 tons), plastics #1 and #2 (221 tons), glass (755 tons), and miscellaneous materials made up the remainder. Living on an island where space is at a premium and there are significant concerns regarding our landfills' future

TABLE 1: Comparison of how recycling operates in Developing countries and Africa

Activities	Developing countries	Sub Saharan Countries
	Hawaii	South Africa
Disposal Procedure	Hawaii Islanders can dispose of cardboard and brown paper bags in one bin and tiny glass containers in another bin at recycling and transfer stations.	South African landfill sites are disposed of differently per municipality. Some have bins for plastic bottles, Metals, and cans and separate places for plants and industrial waste
Operating time	The Country's recycling bins are available from 8 a.m. to 4 p.m. Before you leave, find out which days of the week the recycling and transfer facilities are open	South African operating time for recycling starts from 7 a.m. to 4 p.m. Others start from 8 a.m. and close at 4 p.m.
Incentives	The 5-cent fee incentivizes bringing the bottle container to a redemption center. Redemption centers are located throughout the island	Pickers collect the litter according to their needs and sell it to recycles for incentives this is done by weighing

Recycling stopped for collection	Hawaii County stopped accepting plastics with the #5 (polypropylene), plastic grocery bags, and clamshell-type plastic containers.	Pickers in South Africa stopped collecting plastic due to fewer incentives to receive
Reason for not collecting	The market does not allow for recycled plastics,” and “there is no local outlet on the island that can benefit from plastic recycling.”	Less Kilogram incentive
Green Waste	Green waste is buried and decomposes without oxygen, which releases a large amount of methane. Instead of sending green waste to the landfill, it can be turned into mulch and soil.	The green economy is viewed in South Africa as a sustainable development strategy that addresses the interdependencies between social protection, economic growth, and natural ecosystems. Building on current best practices, initiatives, programs, and indigenous expertise in critical industries is crucial because South Africa guarantees that green economy programs are backed by workable and implementable action plans. "Towards a growth path that is pro-employment, low-carbon, and resource-efficient" carbon and pro-employment growth path

Model for waste collection



Figure 2: Correct way of Collecting waste

Municipal Rate in Developing Countries

Except for Sweden, every nation under consideration has seen an increase in the recycling rate of municipal waste since 2004, a sign of considerable advancements in waste management. A few nations Lithuania, Slovenia, Latvia, Slovakia, and Lithuania have even shown impressive progress, with gains of over 40

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percentage points. The performance of municipal garbage recycling varies significantly between the nations with the greatest and lowest recycling rates. The percentages in 2021 varied from 68% in Germany to 11% in Romania. South Africa charges the rate monthly on affordable fees in the urban area. Other Local townships are not paying rates

Landfills have the potential to cause several issues. Infrastructure disruption, such as damage to access roads by heavy vehicles, may occur. Pollution of local roads and watercourses from wheels on vehicles, when they leave the landfill, can be significant and can be mitigated by wheel washing systems. Pollution of the local environment, such as contamination of groundwater or aquifers, or soil contamination may occur, as well

Waste Pickers in South Africa: Vulnerability Context

The vulnerability context refers to the external environment in which people exist that affects their livelihoods, such as the broader political and policy settings and socioeconomic conditions. The affected persons have very little control over the external environment (Chambers, 1995; DFID, 1999; Scoones, 2009; Nzeadibe & Mbah, 2015). A key, but unrecognised element, in promoting recycling is the efforts by an estimated 60 000 to 90 000 South African waste pickers who make a living from recycling mainline recyclables, either on the streets or on landfill sites. According to a study conducted by Chvatal & de Smit, 2015, the waste pickers' recycling activities are at the lower end of the recycling value chain and yet, over the years, have played a key role in the recycling process (Viljoen, 2014; Samson, 2015). The waste pickers' activities enabled municipalities to save between R309.2 and R748.8 million on air space in 2014 (Godfrey et al. 2016), but the financial importance of their contribution to municipalities has yet to be valued and supported by the recycling sector.

Waste Pickers in Developing Countries

Chambers, 1995; Scoones, (2009) pointed out that livelihoods can be seen as a means of activities, to make a living. Scavengers (Waste Pickers) from many developing countries are benefitting from strong Chinese and Indian demand for recyclables, which has translated into high prices and higher incomes. This has allowed many scavengers to escape poverty. Indeed, waste picking constitutes a common income-generating activity for low-income individuals in developing countries. Approximately 1.5 million people, or 1% of the total population, work as waste pickers in India. There are approximately 9,000 waste pickers in Pune out of the state of Maharashtra with over 300,000 (3 lakh) total. In this sector, 73% of workers are women.

Barriers to entering waste Picker

According to a study conducted by Viljoen, 2014) the author stated that the barriers to entering informal waste picking are considered to be low, however, various other barriers are hindering the waste pickers' access to, collect and sell recyclable waste (Viljoen, 2014). Inclusionary policies and practices towards waste

pickers in the waste management plans of municipalities are becoming critical. The United Nations Research Institute for Social Development (UNRISD,2016) clearly states that no development can be regarded as sustainable if it is not inclusive and participatory and if the affected stakeholders are not able to make decisions on aspects that affect their lives. Unemployment, lack of education, and poverty are the most pinning factors that force youth and women to collect waste

Activity	Description of Objective	Measuring success	Objective met
Income Generation	Increase each waste picker's source of income by 150 per day	The target of 60 percent of youth meeting this goal in a year	Yes 20 out of 25 youths and self-employed from the landfill site
Building houses	Saving money daily	80% of the women mentioned that they build houses	Yes,80% are done with building,50% are done and 20% youth still building.

METHODOLOGY

Seven (7) waste sites Namely Marloth, Secunda, Hazyview Middleburg, Mkhuhlu, Emalahleni, and Kanyamazane in Mpumalanga. The landfill sites visited are from the following districts namely: (Bushbuckridge, Steve Tshwete, Nkomazi Municipality, Mbombela Municipality, and Observations were made and data on the state of the landfill, types of waste recycled by community members, were recorded. A total of 5 landfills in the Mpumalanga Province were included in the study and the relevant data was collected the results were recorded analysed and presented in graphs.

A multiple-case study design and cross-case analysis were used in this study. Case study research is a strategy that focuses on understanding the dynamics present within a single setting (Eisenhardt, Citation1989; Khan & Van Wynsberghe, Citation2008), and combines data collection methods, such as archives, interviews, questionnaires, and observations (Eisenhardt,1989; Baxter & Jack, Citation2008). Case study research further aims to answer the questions 'why' or 'how?'. Analyzing multiple case studies enables the researcher(s) to explore differences and similarities within and between cases, from which new knowledge can emerge. It is important to recognize that case studies do not allow for broad generalizations (Baxter & Jack, 2008

RESULTS AND DISCUSSION

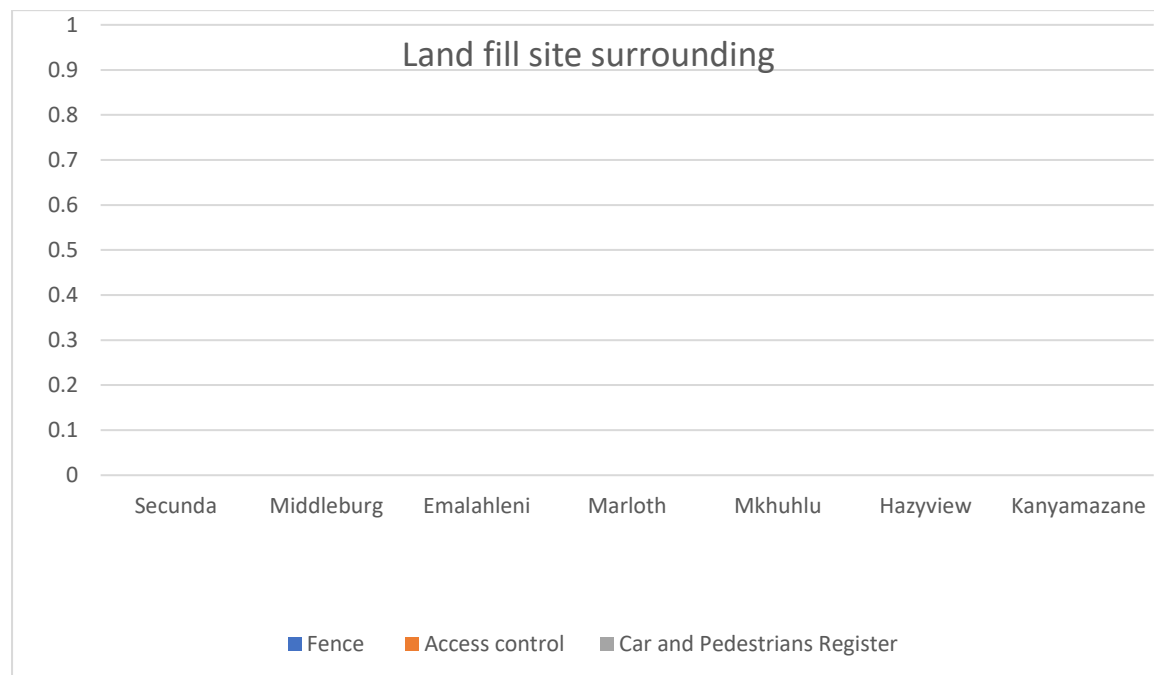
All five districts' dump sites were found to be devoid of any fitted liners. There was no stormwater or leachate management. The ten medium-sized landfill sites that do not produce leachate were the only ones where waste was compacted. Even at these landfill sites, compaction was halted due to malfunctioning equipment or a budgetary error that did not account for diesel and spare parts needed for equipment repair.

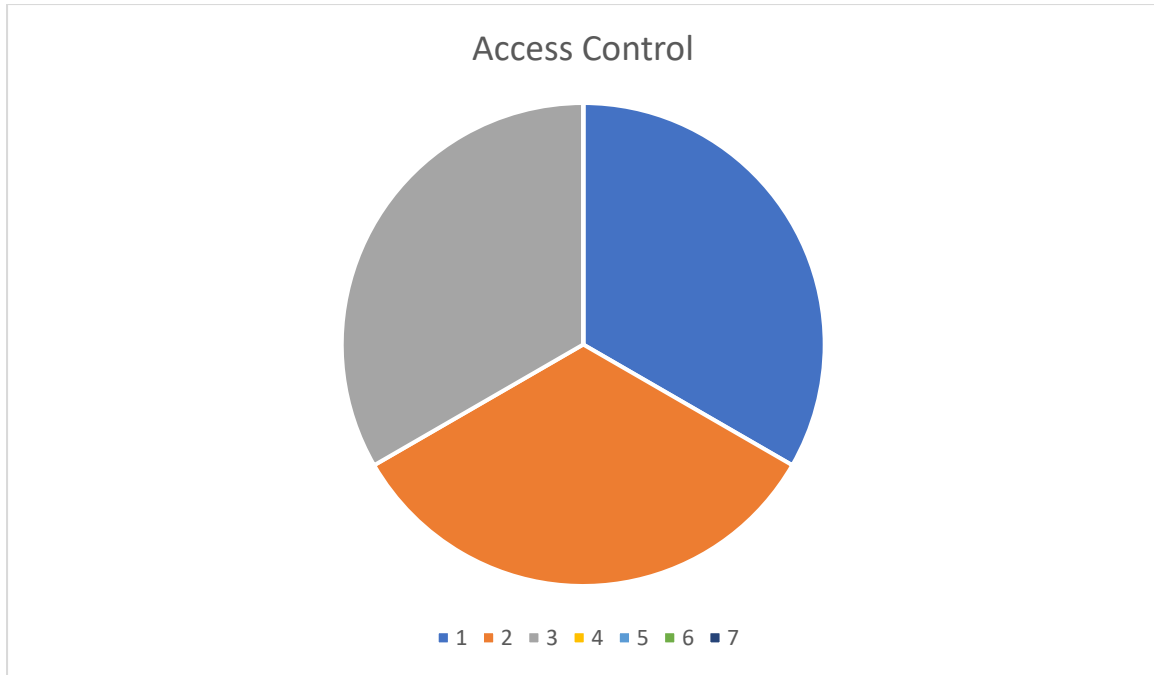
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All landfills visited have ablution areas. We have also noticed the establishment of alien invasive plants in all the landfill sites which require management to stop further spread. Some species were misbehaving and even growing out of the landfilled sites. All species were observed and recorded.

Fencing and access, Drinking water, control, and Register

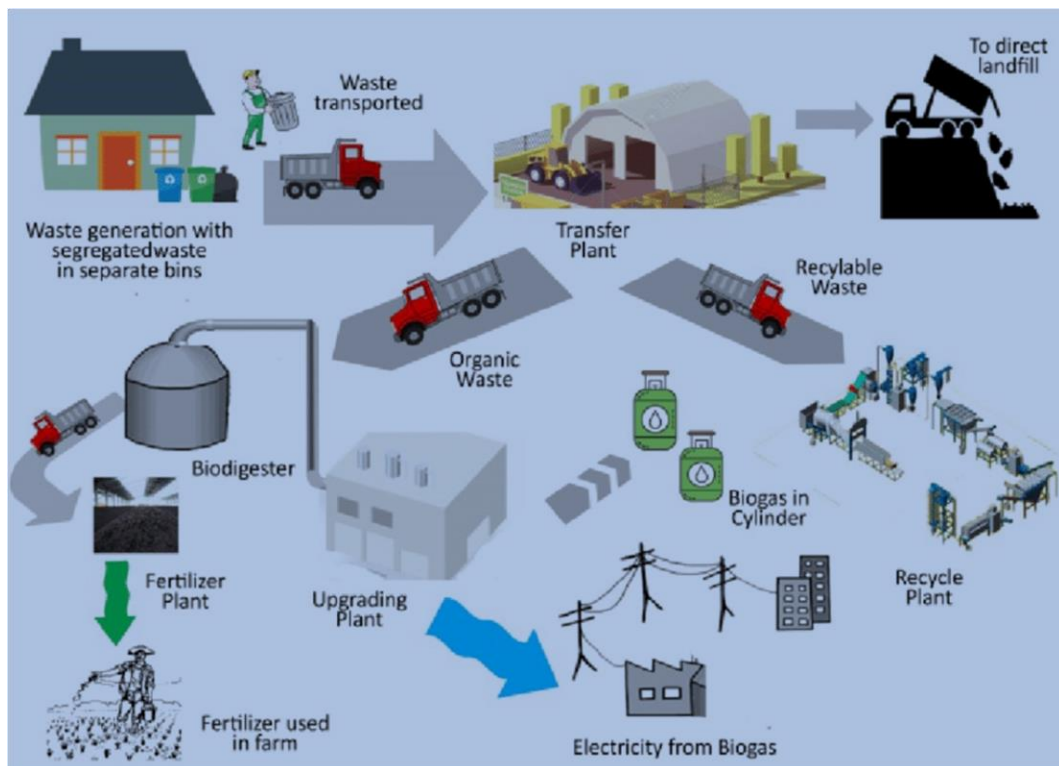
Every dump site needs to be walled, and access needs to be regulated, per the Minimum Requirements. It was clear in all the districts where we conducted our survey they all have fencing but access control regulations were not being followed. Only 20 % and 80% of the waste sites in District 1 were fenced, and access was not followed because there was no security at the gate. Another obvious thing was the lack of gates or access control (locks on gates). 90% of 7 landfills needed access control, which is extremely low. Only one of the disposal sites included in this study had a register where people could enter and record the registration number of the car.





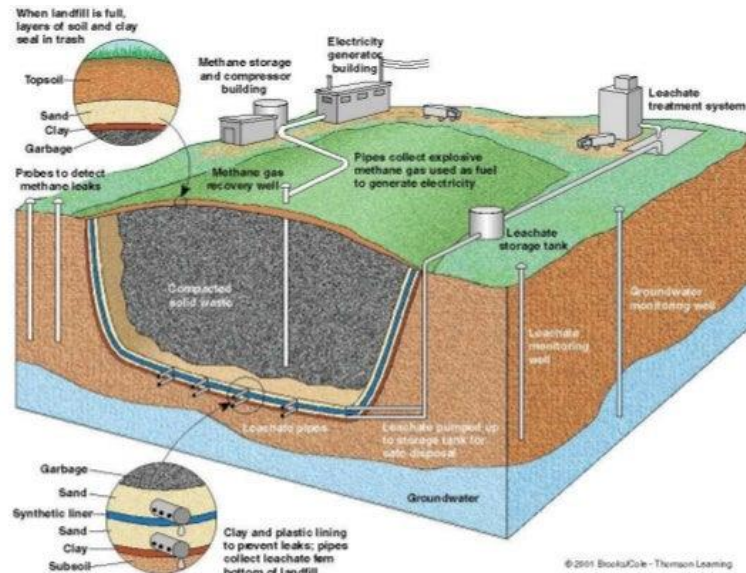
This Pie chart shows the number of landfill site that has access control

Waste Management Model treatment system



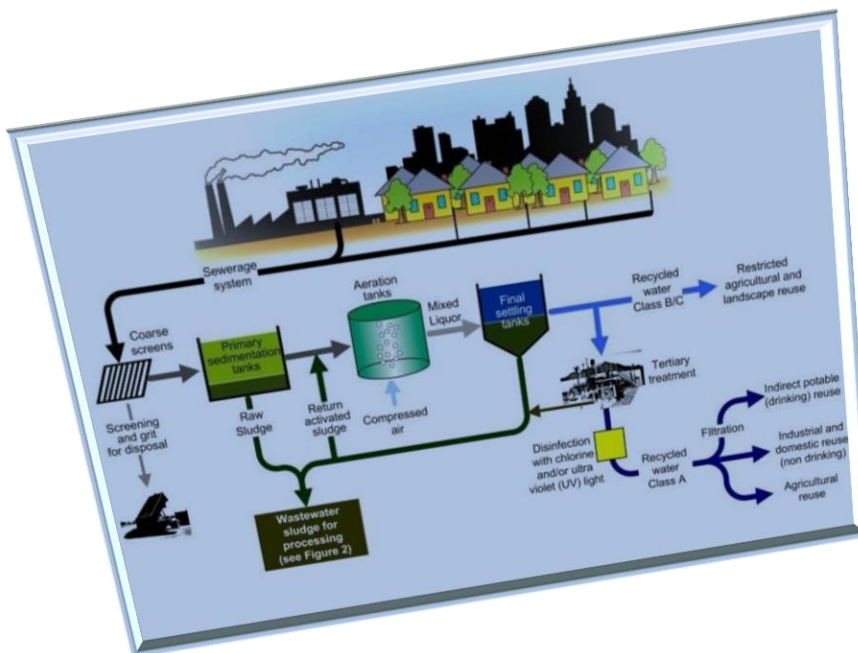
Sanitary towel and dipper disposal way to follow in landfill site

Sanitary towels should be disposed away in a designated bin after being wrapped in plastic or paper to prevent any fluids from leaking. If at all feasible, empty any solid waste into the toilet before packing and discarding diapers to prevent bacteria growth and odor. Due to the lack of a safe disposal option, both wind up in landfills. When disposing of rubbish, always abide by local laws.



Industrial Waste Landfill

They are designed to collect commercial and institutional waste (i.e. industrial waste), which is often a significant portion of solid waste, even in small cities and suburbs.



Key Findings

Municipal solid waste generation is predicted to grow from 2.3 billion tonnes in 2023 to 3.8 billion tonnes by 2050. In 2020, the global direct cost of waste management was estimated at USD 252 billion. When factoring in the hidden costs of pollution, poor health, and climate change from poor waste disposal practices, the cost rises to USD 361 billion. Without urgent action on waste management, by 2050 this global annual cost could almost double to a staggering USD 640.3 billion.

This study has found out that in two out of seven landfilled sites surveyed there are no access controls people can use the landfill site as they wish and can dump waste anywhere without following the proper procedure. The study has found that there is no proper procedure for dumping alien invasive plants in six of the seven landfill sites. Only one landfill site has a hole where they dump any garden waste and burn it. We have also found out that Industrial waste in three of the seven lands filled is collected by the waste picker to do small business with while in another landfill site, they don't collect the industrial waste they focus on collecting metals and copper, paper, and plastic waste

Conclusion and Recommendations

Should the so-called "Landfill sites" in the Free State Province be classified as such or should they simply be called dump sites? INTERIM 39 When compliance with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1998) is used as a guideline to determine the answer to this question, then all waste disposal sites in the Free State Province are dump sites. The handling and disposal of solid waste in the different municipalities in the Mpumalanga Province remain serious problems for the community and impact negatively on the environment. Correct waste handling practices should be enforced on the landfill sites as some of the waste is dumped at the gates of the landfills due to no access control and this may be overcome by training all municipal workers on site to segregate the waste. As very limited recycling is taking place the municipalities should assist community leaders to establish recycling forums and committees of community members who could be trained to effectively start recycling processes for the financial gain of the community members.

The municipalities should take a recent study done on job creation in the waste sector and the role of the waste pickers into account to identify strategies to improve the levels of recycling, identify the most viable products for recycling, and establish markets for the selling of the products suitable for recycling (Schenck et al., 2012). No person should be living on a landfill or dump site. Alternative arrangements should be made to assist community members living on landfill sites to find more suitable accommodation. Municipalities must get actively involved and the housing sections should prioritize the provision of housing for all community workers. If the recycling processes can be structured by the municipalities by providing training to waste pickers it would maximize the recycling, and the waste pickers could sell their products and afford accommodation.

The relevant municipality should negotiate with the recycling companies who remove the recycled products to collect on a more regular basis which would allow the waste pickers to leave the waste sites as they would not have to guard their products from being stolen. Burning of waste on landfill sites should be prohibited. At some sites, tires were burnt and the smoke caused severe air pollution. The old incinerators which are still found on the landfill sites should be removed and the landfill sites should be cleaned up. Municipalities should adhere to the air quality legislation and if they do not comply, the inspectorate responsible for air quality monitoring should prosecute the municipalities who contravene the legislation (South Africa, 2004).

The results described in this article use data and cross-case analyses of seven (7) landfills in Mpumalanga, South Africa. Data was collected through questionnaires and qualitative interviews with landfill waste pickers. To prevent waste pickers from being hit by trucks and tractors, landfill managers have appointed 'pointers' to separate the trucks dumping the waste from the areas being worked on by the waste pickers. The study by Blaauw et al. (2015) confirmed this practice of using pointers to safeguard waste pickers. The structure of the landfill sites must be monitored and repaired where necessary and waste must be done accordingly, waste pickers should avoid mixing the waste when collecting for exchange money as this makes the landfilled site to be disorganized and create a risk to other people.

Health and safety of people at the Landfill site

Since land picking is not a legal or recognized occupation, none of the workers wear the appropriate protective gear. There are additional health dangers associated with working in landfills. Many of the waste pickers brought up how easily they may get cut by needles, glass, and tins especially since they work with these items without gloves or other protective gear. "Cutting your fingers or stepping on a nail" and "We get hurt if we don't have gloves" were among the remarks made by the participants. Van Heerden (2015) conducted a study in which he purchased gloves for the street rubbish pickers he saw and discovered that they favored working without gloves since they could "feel" their collections when they scraped through the waste. Gloves provided by the trash managers revealed similar findings. Additionally, the researchers noticed that some of the masks provided to waste pickers in landfills were unclean and were just hanging around their necks. The chance of getting struck by a truck was found to be one of the biggest hazards at the disposal sites. Participants made the following observations: "People rush and push each other when trucks come in. If you're not careful, the trucks can hit you." The waste pickers also cited eating rotten food, drinking improper beverages, and coming into contact with contaminated water and rotting food. This involves coming into contact with "snakes" and "nappies and aborted babies."

Financial assets

The participants revealed that, given the low barriers needed, rubbish picking was frequently "the only option" for them to make a living on the landfill. One more important advantage of recycling that the waste pickers shared was having access to "quick money" or a "daily income." They clarified that the money received varied every day and was not consistent. The amount of recyclable rubbish that was brought to

the dump, the ease of access to the recyclable waste, the weather, their health, and the variable costs of the recyclable waste were all factors that affected their revenue. For these reasons, the real weekly salary of the waste pickers was recorded before the interview. Participants who want to venture into the waste collection business must follow these steps: Step 1: Choose a Waste Industry Sector, Step 2: Craft a Simple Business Plan, Step 3: Register Your Business and Obtain the Proper Permits, Step 4: Purchase the Necessary Equipment, Step 5: Advertise Your Waste Collection Business.

Institutional processes and policies

Institutions such as the municipality or the private waste management company responsible for managing the landfill, as well as the BBCs, played the most significant role in the lives of the LWP. Without the existence of the BBCs, it would not be possible to collect and sell recyclable waste (Viljoen et al., Citation2012). On visiting the different BBCs, it emerged that complex price structures depended on a variety of factors, such as transport costs, quality of recyclable waste, and global macroeconomic price fluctuations.

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