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Challenges of Landfill Operation in Tanjungpinang, Kepri, Indonesia

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Abstract: A controlled landfill is one of the ways to manage the waste generated, which is laid between open dumping and sanitary landfill. Ganet Landfill is the only one landfill located at the Tanjungpinang, Indonesia. Currently, this landfill face the operational problem and abundant to the environmental problems. This study consists of the three objectives, (i) to study the current problems of controlled landfill operation; (ii) to determine the challenges of controlled landfill operation affect the surrounding environment, and (iii) to suggest an improvement and innovation to the controlled landfill operation. The case study was conducted at Ganet Landfill in Tanjungpinang, Indonesia as a controlled landfill. The qualitative method with the semi-structured interview instrument used in this research. The data collection involved four respondents from Ganet Landfill office and the Department of Public Housing and Peoples' Settlement Riau Archipelago. Finding shown that the most dominant current problem in Ganet landfill is the lack of manpower, lack of heavy equipment, lack of land for the future, lack of infrastructure leading to unloading points. While the challenges faced in operating Ganet Landfill as a controlled landfill are meeting the needs of the present and future communities and spread knowledge about landfills among staff and the community. Therefore, the suggestion the improvement and innovation to the Ganet Landfill are change the controlled landfill to the sanitary landfill, cooperation with the private sector to improve the landfill operation, increase waste processing from households, and increase community concern about the landfill to make sure the controlled landfill is in line with sustainable development at the local and national perspective.

Keywords: Controlled landfill, landfill operation, technology

1. Introduction

Solid waste was among the issues, especially in developing countries which lack adequate infrastructure and accessible land mass to properly process it (Yukalang, Clarke, & Ross, 2018). Previous research indicated that there were several methods to manage solid waste such as sanitary landfill, sewer discharge, open dumping, incineration, compaction, milling, dumping, anaerobic digestion and composition (Mohamad Zailani & Zin, 2018). However, landfilling was the most frequently used and had been used for many years (Akinbile & Yusoff, 2011). Landfill one among the ways in which to manage solid waste, used for accommodating the solid waste and isolating the waste that

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might cause environmental hazards, water pollution and air pollution. Landfill was land that used to accommodate and collect the waste, but the concept had changed over the time and progress towards technology and innovation. Modern landfills were requested to be located, able to process, maintain and not contaminate the surrounding environment and had been designed to the state-of-the-art technology (Meegoda, Hettiarachchi, & Hettiaratchi, 2016);it could offer a relatively straightforward and affordable option for the disposal.

There were several types of landfills such as sanitary landfills, industrial landfills, construction and demolition waste landfills, controlled landfill, etc (Ministry of Environment New Zealand, 2018). But here, the study was focused on controlled landfill which was operated in Tanjungpinang, Indonesia. It was observed the current problem regarding the operation of a controlled landfill, the challenges on the operation of controlled landfill, and suggest the improvements on the ways of controlled landfill operations. From European Environment Agency, controlled landfill was landfill whose activities are subjected, in accordance with current national legislation, to a permit system as well as technical inspection (European Environment Agency, 2016). A major improvement of the municipal open dump was controlled landfill. The field was closed for access control and at the end of each day; waste was filled or covered with soil (Open Learn Create, 2020). Controlled landfill is a method by collectors of waste of all types in a specified area and typically is controlled by the government of the city or the state (Arogundade, 2020). In urban areas, controlled landfill are often found and as they are operated by the government, some waste sites have certain features of the sites, such as utilization tenure, simple record keeping, waste coverage, etc (Arogundade, 2020). Ganet Landfill is the only one landfill located at the Tanjungpinang, Indonesia. Currently, this landfill face the operational problem. The problem brought it from the status of the sanitary landfill to the controlled landfill. This study consists of the three objectives, (i) to study the current problems of controlled landfill operation; (ii) to determine the challenges of controlled landfill operation affect the surrounding environment, and (iii) to suggest the improvement and innovation of the controlled landfill operation.

2. Literature Review

Controlled landfill was a landfill site which gave appropriate level of compaction, waste covering, and leachate shelter and treatment (Oduro-Appiah, Scheinberg, Miezah, Mensah, & de Vries, 2019).This landfill was still an unacceptable operation, as it did not comply with the fundamental landfill principles of waste compaction and covering. But still, it was a astep higher than the open dumpsite (Kurian, 2020). It means turning an open dump into a controlled dump would require a landfill at a site for which open dumping had already been used. The planning of the area would thus involve, among other things, leveling and compacting the current waste heaps and constructing irrigation canals or ditches.

2.1 Landfill Function

Modern landfills were well-designed and operated waste storage sites. Landfills were identified, planned, maintained and supervised to ensure consistency with federal legislation (EPA, 2020). The function of landfill was isolating waste from its surroundings to prevent water pollution and air interaction (Advanced Disposal, 2019). Besides, the landfill was used to storage and treatment, environmental protection, and land development (Izni Izzati, Mohd Zulkifli, & Ahmad, 2018). In particular, the role of land development is an important topic for the Indonesian landfill site. However, landfills were common final disposal site for waste and residues remaining from other treatment options (Hicks & Verbeek, 2016).

During the target lifetime of the site, each controlled waste site must be kept in a workable condition. A controlled waste disposal of municipal solid waste would be used as a reactor in which primary components including waste and water were entered, then other items such as leachate, biogas and heat were produced through biological and physical-chemical processing (Emmi, Zarrella, Zuanetti, & De Carli, 2016). Waste production is a direct consequence of the urban life and there was the need to build structures to store them. It was designed to monitor and avoid any hazardous substances in a waste containment system. The performance criteria of the system was an adequate structure, which encompasses all areas of strategy, architecture and delivery, accompanied by accurate testing to ensure that the operations were smoothly operational and completely compliant with the established requirements (Emmi et al., 2016).

2.2 Classification on Controlled Landfill

Currently three standard categories of landfills were municipal solid waste, industrial waste and toxic material waste (Behm, 2020). Every form of waste acknowledged and had different practices to reduce the environmental effects. In addition, there was an evolving form of landfill-green waste-that permitted regulated disposal of organic materials (Behm, 2020). However, it also said that when learned about different landfill types, it started to understand why there were restrictions on what could be tossed with curbside trash or why certain dumpsters could only take specific materials. Table 1 shows the types of landfills.

Table 1- Type of landfill (Behm, 2020)

Types of Landfill	Waste collected
Municipal Solid Waste Landfill	Mostly residential waste or household waste, commercial solid waste, hotel wastes, school wastes (Mouhoun-Chouaki, Derridj, Tazdaït, & Salah-Tazdaït, 2019)
Industrial Waste Landfill	Industrial waste such as contruction debris disposal, rocks or soil from excavation, glass, sand, clay, etc (EPA, 2015)
Hazardous Waste Landfill	Hazardous waste such as flammable liquids, radioactive substance, corrosive substances (Machete & Shale, 2015)
Green Waste Landfill	Organic materials such as fruits, vegetabes, tree branches, fowers and grass trimmings (EPA, 2016)

The municipal waste disposal method was the earliest and most widespread means of disposing and disposing of waste. (Vaverková et al., 2018). An region of discrete landfill or excavation collecting household waste was a municipal landfill site. Other non-hazardous waste, including commercial solid waste, non-hazardous containers, low-quantity engine waste, and non-hazardous industrial waste were also shipped (EPA, 2016). Although the EPA claimed that industrial landfill sites were a site other than urban solid site sites such as road construction material, excavated material, excavation waste, construction or reconstruction waste and site clearing waste (EPA, 2015). Due to industrial practices, waste production in the processes of manufacturing was made useless by incuding products such as food and chemical, mill, plant and mining (Awuchi, Chinaza Godswill, 2020). Forms of industrial waste were soil and gravel, concrete and mansion, solvents, additives, scrap timber, scrap meta, gasoline etc.

There was also an additional waste-dumping classification method as seen in Table 2 where after the enactment of Waste Act 18/2008 by the Indonesian Government, the dump sites examined had applied "controlled dump site" as opposed to the engineered dumping site (Idowu et al., 2019). The key causes behind the shortcomings were inadequate waste management and administration costs along with the presence of scavengers at the disposal site (Munawar, Yunardi, Lederer, & Fellner, 2018).

Table 2 - Practice and operational based classification of landfilling systems (Idowu et al., 2019; Munawar et al., 2018)

Classification	Levels
Open Dumpsite	0
Controlled tripping	1
Sanitary landfill with a bund and daily cover	2
Sanitary landfill with leachate recirculation	3
Sanitary landfill with leachate treatment	4

2.3 Operation of Controlled Landfill

Landfills were important waste management component but could cause serious damage to the environment. A suitable design and operation was therefore needed. A general description of the landfill operation, particularly regarding landfills for municipal solid waste was provided, followed by an overview of the landfill concepts (Ramke, 2001). Controlled landfill of municipal solid waste might well be known as a reactor where the primary components entered and then other materials such as leachate, biogas and heat were produced using biologic and physico-chemical processes (Emmi et al., 2016). Controlled landfills have been distinguished by internal heat generation due to aerobic and anaerobic processes; waste volumes had also been heat exchanged with everlasting air and the surrounding soil (Emmi et al., 2016). In the procedure of phase of the waste disposal, considerations such as the techniques, the other of landfilling, the regulation of slopes throughout landfill, the use of cover soils, etc (Yachiyo Engineering Co. & Ex Corporation, 2004). Landfilling process include the entire range of activities including the delivery into the deck sites of solid wastes, the dispersal, mixing, the application of end-use cover and other landfill activities (Yachiyo Engineering Co. & Ex Corporation, 2004).

Badan Standarisasi Nasional Indonesia explained in the regulation of the Minister of Public Works that the scope of implementation of landfill operations and maintenance activities incuded making routine action plans for handling waste in the landfill area as well as those related to the operation of other facilities and infrastructure. Construction and ongoing installation activities of landfill basecoat systems, gas ventilation systems, leachate collection system construction, installation of gas capture systems might also be considered and provided according to standards before actually starting

waste management operations (Badan Standarisasi Nasional, 2002). After all facilities were installed and ready to use, the operation started with managed and noted wastes that came into the landfill. Then the waste would be unloaded and compacted. Waste that would be processed by landfilling or hoarding after being recorded would be brought to a predetermined landfill place. It was prohibited to pour garbage anywhere except in the places designated by the field supervisor (PT. Wastu Asrindoriau, 2008). They also state the location of the unloading point should be clearly arranged and informed to truck drivers so that they dumped at the correct point so that the next process could be carried out efficiently. The unloading points were generally located on the edge of the cell being operated and close to the work road so that trucks could easily reach them. After the trucks carried out their duties, the waste leveling and compaction work was carried out by taking into account the efficiency of heavy equipment operation. Leveling and compaction of waste was intended to obtain conditions for efficient land use and good landfill surface stability.

PT. Wastu Asrindoriau (2008) also highligthed that the leveling and compaction of waste must be up to a height of 1.5 meters with a slope of about 30-45 percent. Compaction by the dozer was carried out up to at least 5 times grinding to get the heap as compact as possible. Each 25-30 meters wide zone would be able to simultaneously receive 5 trucks with a working face width of approximately 5 meters for each truck that wouuld be unloading. Meanwhile, landfilling during the rainy season was carried out in cells adjacent to the operating and working roads. Pouring garbage could be done directly from the road, but heavy equipment was still needed ot level and compact the waste. The final cover in the controlled landfill consisted of several layers starting from the bottom up, namely regular (daily or intermediate) cover, a layer of clay with a thickness of 20 centimeters with a maximum permeability of $1x10^{-7}$ cm/s, and finally topsoil with a minimum thickness of 60 centimeters (PT. Wastu Asrindoriau, 2008). They stated covering the waste with soil and the process of compaction was carried out in stages cell by cell, so that after the first layer of cells was finished, it could be continued by making the next layer above it. The cover soil should not be eroded while waiting for use, such as eroded by rain, routine operation, and eroded due to previous heavy equipment operations on it. Figure 1 below show the cover soil layers of controlled landfill.

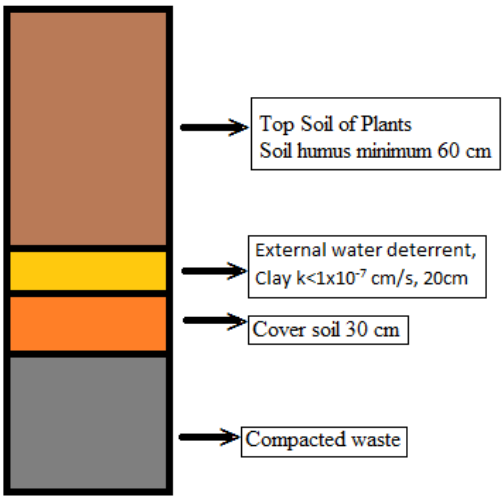

Fig. 1 - The layer of cover soil applied on controlled landfill (PT. Wastu Asrindoriau)

2.4 Problem on Operation of Controlled Landfill

The increasingly affluent lifestyles and continued industrial and commercial production of municipal solid waste had also continued to expand in many countries around the world. While the only secondary contaminant generated by the main waste management during the landfilling, there was still a lack of knowledge regarding the production of heavily contaminated leachates, major improvements in their chemical composition, fate, migration and substances in the processing, storage and proper handling of highly contaminating leachates in a thorough scientific literature (Schiopu & Gavrilescu, 2010). Schiopu & Gavrilescu (2010) mentioned the modern landfills were highly engineered facilities designed to eliminate or minimize the adverse impact of the waste on the surrounding environment, as a result of gas emissions and leachate soil percolation. Therefore, there was a need to developed reliable and sustainable options to treat and manage landfilling, as well as leachate effectively.

Landfills were central to the country's waste management system, because they ended up storing most of its household waste. Because of this, in Indonesia, the 2008 Waste Management Law requires every region to manage their waste at a sanitary site rather than in open-dumping site (Kahfi, 2019). At a landfill, the waste was burried or covered to accelerate decomposistion and prevent it from buring or becoming a source of diseases. However, most regions in Indonesia still used open-dumping. According to 2018 Environment and Foresty Ministry data, more than half of

Indonesia's landfills operated as open-dumping sites (Kahfi, 2019). Most of these people said that waste toxins such as arsenic, acids, lead and others which eventually end up in the atmosphere and pose a public danger were the problem directed towards deposits operations; liquid leachate that developed when waste from waste sites broke down and water filters through waste and captured toxins; and greenhouse gas generated from waste as methane that was also inflammable at large concentrations could be very dangerous (Bausback, 2016).

2.5 The Challenges in Controlled Landfill

As one of the developing countries, municipal waste management was still a problem that had not been resolved to date in Indonesia. The increase in the amount of waste generated continues to occur as a result of the increase in human population, daily needs and the economy sector development (Koderi, Suyadi, Said, & Muhaimin, 2018). So far, landfill management system in Indonesia mostly still applied open dumping system, so it tends to have negative impact to the surrounding environment such as soil, water and air contamination, odors, disease vector, etc (Debby Rizani, Antariksa, Surjono, & Rini Dwi Ari, 2016). Not only that, the increase in transport and traffic activity caused to the move of waste collection vehicles, material vehicles, and equipment would be one of the main impacts for surrounding area (Yachiyo Engineering Co. & Ex Corporation, 2004). To accommodate the rise in traffic volume, roads leading to the waste disposal must be properly maintained and strengthened. There should be ample access and exit to the location of landfill in order to prevent any traffic jams at the gate (Yachiyo Engineering Co. & Ex Corporation, 2004).

On the other hand, another challenge on controlled landfill operation was the lack number of workers (El-sherbiny, Gaber, & Riad, 2011). El-sherbiny et al. (2011) mentioned the landfill sector suffered from a shortage of well-trained staff in waste management. The poor employers' awareness of the complexity and benefits that the proper implementation of occupational safety and health brought represents the biggest problem at landfills and utility companies. Many experienced landfill operators were reaching the age of retirement, and there was no one to fill their shoes. The economy further influences the availability-lack thereof-skilled equipment operators. During economic booms, equipment operators typically rush to higher paying construction jobs.

2.6 Innovation on Controlled Landfill

It was also suggested that landfills were comparatively cleaner than other waste disposal methods (Miller, 2017). Incinerators, in particular, might be very dangerous to their radioactive materials, and, of course, landfill sites also had their share of risk, though not as severe as other approaches (Ezaydi, 2019). If not properly sealed, toxic chemicals could contaminate the surrounding soil and water supplies. It had already contributed to deforestation and climate change. Ezaydi (2019) also highligth the incinerator provided substantial greenhouse gas benefits relative to the landfill site and prevented the major effects of the landfill - the loss of hazardous substances to the environment and the emission of methane. Table 2- 4 shows that the pros and cons about the method of solid waste management by landfill and incinerator. Both landfill and incineration, as well as waste disposal processes, had their environmental disadvantages. So there was no clear case, either way. Both strategies were responsible for the release of pollutants and toxic by-products (Ezaydi, 2019). However, incineration also had an electricity supply, which was why it had any need for it.

Table 3 - Comparison between landfill and incinerator (Ezaydi, 2019)

Method	Pros	Cons
Landfill	• Get rubbish out of the way so maintains cleanliness and hygiene • Convenient to use as it does not require too many resources • Organic degradation means some carbon is stored and sequestered	• Releases methane gas • Releases carbon emissions via transportation of waste to landfills • Contaminates surrounding land and water sources • Running out of space for landfill sites
Incinerator	• Can be a source of energy for homes, building, etc. • Avoids the contamination of surrounding land and water sources • Avoids the release of methane - a greenhouse gas	• Releases carbon emissions • Expensive and resource heavy • Requires a constant and regular supply of waste to run efficiently • Produces residual incinerator ash (IBA) - which requires its own safe waste disposal or storage

Mortan (2017) shows solid waste had played an important role in a variety of objectives, including ensuring sanitation for everyone, making towns and human settlements sustainable, promoting sustainable use and reducing climate change. He also mention the financial services needed were not only projected to be significant in the "thousands" of dollars annually, but they far exceed the existing "billions" of dollars annually in financial flows from development agencies. Morton explained the strategy would give preference to private finance options more consistently if they were feasible. That was, private solutions that were still operating would be seen as a first choice; followed by promoting private activity by reducing policy and regulatory gaps and risks that currently deter participation; and, ultimately, as a last option, where private solutions could not satisfy all the criteria of the field, public funds might be used strategically. It also added, because of the public nature of many solid waste services, public-private partnerships (PPPs) were a key mechanism to engage the private sector.

Besides, At-source waste sorting by householders was indicated to be appropriate. However, most households could not sort their garbage, and domestic waste was a combination of bio-waste, inorganic waste, toxic waste and solid waste (Aprilia, Tezuka, & Spaargare, 2012). It means waste sorting used to take place outside the home by waste carriers and physical worker at temporary collection sites and waste management or recycling facilities. The desire to accept waste sorting by people who had not yet accepted it was more likely if incentives, information and assistance provided. Aprilia el at. (2012) also stated that increased information from waste service providers and government on the processes of waste storage and final disposal were intended to increase public understanding and active involvement in waste sorting at source. The fresh method to encouraging at-source sorting was through voluntary initiatives, in particular the implementation of rewards through revenue from sorted recyclable waste and revenue from home and communal composting (Aprilia et al., 2012). While many forms of rewards were available, they were not adequate to enable the community to sort their waste. Thus, Aprilia added the regulatory action would have had to be considered by drawing up a regulatory system for the order for household sorting with sanctions or fines for householders who had not properly sorted their waste. While people had demonstrated a significant level of willingness to sort their household waste, careful control would be needed to ensure that sorting was effective.

It was increasingly important to consider the effects of people's participation in day-to-day behaviors, such as waste sorting. However, issues such as whether eco-ethical contemplation on the effect of disengagement from waste management or knowledge of what could be done from the recycled waste impacts of participation in waste sorting appeared to have been ignored in research at the present time (Hellwig, Häggblom-Kronlöf, Bolton, & Rousta, 2019). Hellwig added there was a desire to better consider how people thought and behave rather than solely concentrate on the qualitative or technological dimensions of the waste scheme. There was an immediate need to capture people's viewpoints on waste sorting in a culturally aware and holistic way in order to identify ways to enable diverse communities to live a healthy day-to-day existence.

The concern about waste disposal sites had escalated due to their extremely severe off-site impacts, in particular water quality and the health consequences of the installations (Lemon & Melosi, 2000). There had been many significant pressures influencing the community's worries regarding landfills in less developed nations, which were either distinct from or developing towards those seen in advanced countries (Tuan, Maclaren, Phong, Chi, & City, 2007). First, the general lack of understanding among rural communities about the effects of large, poorly maintained landfill sites might make some of the advocates of landfill sites in less developed countries with little difficulties. Second, in many less developed nations, policy systems banned marches or gatherings and strongly curtail or totally eliminate the prospect of popular interest in decision-making (Tang, Tang, & Lo, 2005). If these policy regimes liberalized and encouraged public opinion about polluting facilities to be voiced, the volume of 'overt' resistance started to climb. A third aspect of community interest was whether authorities in less developed nations frequently lack the ability or desire to implement current laws on waste disposal and the environment (Tuan et al., 2007). The fourth element at the core of the development of neighborhood fears over landfills in less developed countries was a dramatic rise in the valuation of urban land as a result of accelerated urbanization. While the rate of urbanization had been stable over the last several decades in societies, many developing countries had experienced accelerated urbanization growth rates. To create environmental awareness, it was necessary to have prior knowledge about the environment that came from learning independently by reading books, from other media such as television, the internet, and it could also come from the classical teaching and learning process (Lestari, 2015, Seow & Abas, 2015, Abas & Seow 2018).

2.7 Sanitary Landfill Basic Information

There were several levels owned by sanitary landfills for classification. That level depended on what facilities the sanitary landfill had. In principle, both the USEPA standards and the Malaysian technical guidelines were complied with in the design of landfill sites (Malek, 2008). The Malaysian Technical Guideline divides waste into four levels, which were level one until level four with obviously different facilities. Level one was known as controlled tipping sanitary landfill, level two was sanitary landfill with a bund and daily cover soil, level three was sanitary landfill with leachate recirculation system, and last level four with leachate treatment facilities (Malek, 2008). The designation was used to assess the required standard of change to be accomplished based on factors to the site requirements, financial constraints,

planned infrastructure, post closure land used, etc (Yachiyo Engineering Co. & Ex Corporation, 2004).In Table 4 shows the sanitary landfill site levels facilities provided.

Table 4 - The sanitary landfill site level (Malek, 2008)

Facilities	Level 1	Level 2	Level 3	Level 4
Soil cover	*	**	**	**
Embankment		**	**	**
Drainage Facility		**	**	**
Gas venting		**	**	**
Leachate Collection			**	**
Leachate Recirculation			**	**
Leachate Treatment				**
Liners				**

*to be provided periodically
*to be provided daily

Level one of sanitary landfill only had controlled tipping (Malek, 2008). It was the lowest level of sanitary landfill which equivalent, in theory, to sanitary landfills, but at a smaller scale than was acceptable for rural areas. Solid waste was disposed of in a dug pit in managed tipping or disposal and periodically was filled with soil, to prevent attracting vectors for infection, including flights and mice (Openlearncreate, 2019). In this landfill, the site was staffed and there were some containment and management of combustion process with basic operating procedures to control nuisance. The achievements of these sanitary waste disposal levels included providing well maintained access to the premises, providing regular coverage material to prevent waste dissemination, minimizing odors and fires, and providing basic management systems for inspection, inspection, and daily logs of income waste (Yachiyo Engineering Co. & Ex Corporation, 2004). Level two of sanitary landfill designed with a bund and daily cover soil. Solid waste disposal and well defined surface water and cells should be built and bonds should be used to separate the filled and unfilled site phases (Yachiyo Engineering Co. & Ex Corporation, 2004). Daily cover was the term to describe material spreaded over deposited waste at the end of each working day (Ireland EPA, 2014). The soil cover should be provided daily or appropriate synthetic materials might also be used. Key daily cover goals could include wind blown pollution avoidance, birds or other wildlife scavenging deterrent, avoiding fly infestations and reducing emissions of odor and slurry gas (Ireland EPA, 2014). A sanitary landfill met the site limits that specifically demarcated the waste landfill, provided the required regular covering of soil, supplied the waste container with the surroundings, supplied of storm water drainage systems for the ground and perimeter, supplied of environmental protection systems, such as the buffer zone, regulation of liter and facilitation of ventilation of gas (Yachiyo Engineering Co. & Ex Corporation, 2004).

Level three of sanitary landfill was an improvement to the level two sanitary landfill by the provision of leachate collection and recirculation system. Leachate recirculation was defined as the practice of returning leachate to the landfill from which it had been abstracted (Environment Agency & IPPC, 2007). A series of leachate pipes were collected and then recycled to the waste layer so as to reprocess and decompose it further, thus enhancing the quality of the leachate. Furthermore, the recirculation promoted faster evaporation and reduced the amount of effluent thus (Yachiyo Engineering Co. & Ex Corporation, 2004). Level four of sanitary landfill was made with leachate treatment facilities. While level three of landill was the improvement of level 2, level four was the improvement of level three. Through resisting the absorption of leachate into the soil, the liner device acted as a barrier to the abstraction function (Yachiyo Engineering Co. & Ex Corporation, 2004). The leachate flowed to the storage tubes for further processing and was added to the leachate retention pond. The treatment process for the waste wastewater enhanced and accelerated by aerators or air diffusers (Yachiyo Engineering Co. & Ex Corporation, 2004). The achievements of sanitary landfill level four were provision of leachate treatment facilities with the installation of oxidation pond, provision of liners to control the seepage, and establishment of semi-aerobic sanitary landfill (Yachiyo Engineering Co. & Ex Corporation, 2004). Currently, there are many study using biotreatment in sanitary landfill technology (Er et al. 2018a, Er et al. 2018b and Seow 2016)

3. Research Method

This study used a qualitative method to achive the research objectives and focusing in operation of Ganet Landfill as controlled landfill. Interview method had been chosen for instument of this study.

3.1 Interview Instrument

The research method that used was semi-structured interview with staffs, workers, and employees that had been involved in Ganet Landfill Operations. There were four respondents that had been interviewed during this study on November to December 2020 which three respondents is from Ganet Landfill office and one respondent is from The

Public Housing Office for the Cleanliness and Gardening area of the Province of Kepulauan Riau Indonesia. This research were focused on current problems regarding to the operation of landfill, challenges regarding to the operation of landfill and method used to improve the operation of landfill in Ganet Landfill Tanjungpinang, Indonesia.
There were five parts of questions that would be used in interview which were involved Part A, B, C, D, and E. Part A consited of questions related to information about the background of the respondent. Part consisted of basic information about the landfill. While part C consisted of questions related to current problems regarding to the operation of landfill. Part D asked about the challenges regarding to the operation of landfill and part E was asking about the method of improving the operation of landfill. Table 5 shows the elements of interview questions.

Table 5 - Element of interview questions

Part	Element	Potential Answer
A	Background of respondents	Background of respondent
B	Basic information about the landfill	General information about landfill
C	Current problems regarding to the operation of landfill	RC1, RC2, RC3, RC4
D	Challenges regarding to the operation of landfill	RD1, RD2, RD3, RD4
E	Method of improving the operations of landfill	RE1, RE2, RE3, RE4

*R=Answer, C/D/E=Question Part, Number= Number of each respondents

Content analysis is used in this study, where collected data were systematically analyzed and arranged to be properly defined. After the process of analysis data had been done, the suggestion to improve the operation of controlled landfill in Tanjungpinang were provided.

3.2 Ganet Landfill

Ganet Landfill is located in Tanjungpinang, Indonesia. The landfill was located near to Ganet area in Tanjungpinang, Kepulauan Riau, Indonesia with coordinate N 0˚93.854', E 104˚53.332'. The landfill had been operated around twenty of years with land area of 14 hectares near to the Raja Haji Fisabilillah International Airpot. There were 90 tonnes of the capacity were estimated to this landfillreceived per day.

4. Result and Discussion

4.1 Background of Respondent

The study involves four respondents. Three of them is representative from the Ganet Landfill Office, and one representative is from Department of Housing and Peoples' Settlements Riau Archipelago. Table 6 shows the information of the respondents.

Table 6 - Respondent background

Respondent	Company Name	Position	Work Experience
R1	Ganet Landfill Office	Heavy Equipment Operation Supervisor	20 Years in Ganet landfill
R2	Ganet landfill Office	Staff of Leachate Monitoring, Fecal Sludge Treatment Plant, and Methane Gas	2 Years in Ganet landfill
R3	Ganet landfill Office	Head of The Waste Management Department	2 Years in Ganet landfill
R4	Department of Housing and People's Settlements Riau Archipelago	Staff of Environmental Sanitation and Sanitation	1 Year in Department of Housing and Peoples' Settlements Riau Archipelago

4.2 The Current Problem in Ganet Landfill as Controlled Landfill

All respondents were told that a lot of people were aware of the understanding of landfill and sanitary landfill. Ganet Landfill in Tanjungpinang, Kepulauan Riau, Indonesia was treated as sanitary landfill in 2012 to 2018, the workers was familiar to operate it. Since 2018 the landfill has been change to the controlled landfill. **Fig. 2** shown the problems posed by all respondents. The problems that could be visually seen during the interview was bad infrastructure, which was road access to the point of unloading. respondents said that during the storm, the road was so muddy that the unloading point had to be changed to another location. The lane did not have asphalt or concrete on it. The path used only the location's natural ground, making it impossible for lorries and other large vehicles to drive through.

In addition, the location of offtrack waste was also one of the problems that arose during waste processing. This was achieved by the local population who placed garbage outside a predetermined road, such as in front of the house that is not warranted. This lead to waster collector warker needs to work more to exceed the quotas stated. On the other hand, respondents 1, 2, 3, and 4 reported that shortage of manpower was another concern. They said that only twenty-six workers at the Ganet Landfill. As the landfill was fourteen hectares wide, the lack of manpower forced the landfill operation to run slower. Currently, the operation of landfill was limited because of there is only four heavy machinery, two bulldozers, one excavator, and one loader. To operate about ninety tons of waste daily with the limited of the equipment it make the difficulty during managing the waste at the landfill site. Heavy equipment was used to organize, compact and cover the waste with soil. Those heavy equipment played an important role in the daily landfill activity. Afterwards the land of the landfill was currently sufficient for the waste to be accommodated. Yet there were just two hectares remaining that were not used for anything. Eight hectares out of the fourteen hectares of landfill were used for landfilling, and four hectares were used for offices, garages, and other services. The respondents said that in the future the land could not be enough for the waste generated. The landfill had to acquire additional space in the future. If the landfill is not changed, the remaining two hectares would be worse.

Machinery used to handle the gas generated by the pile of waste was another problem described by respondents. Methane gas generated from the waste in the form of diesel and gasoline converted into petrol. The issue arose when the methods used for processing were broken down. For such gases, Ganet Landfill had just one flaring tool and station. The method of transforming the gas was not performed well until the machine became normal after the machinery was destroyed. It was a shame that it was not possible to process the gas optimally. From previous shows shown that one of the problems regarding to the landfill was bad infrastructure at landfill site. Besides, the previous study also shown that government broke the agreement with the contractor at landfill site because of the truck problem like truck used standard , track or route of the truck and operational hours of the truck (Mulyadin, Iqbal, & Ariawan, 2018).

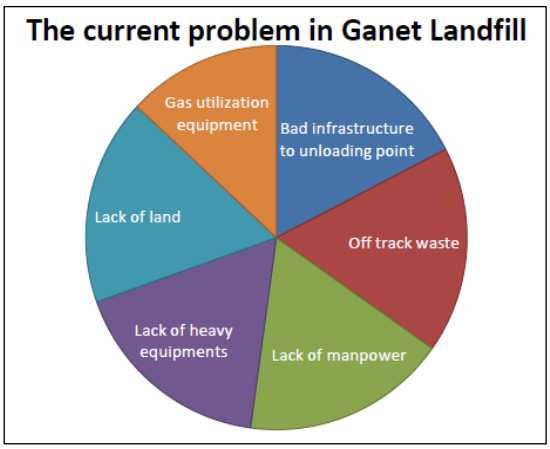

Fig. 2 - Problems in Ganet Landfill

Mulyadin et al (2018) also added that the increase in waste that occurred is not balanced with the number of fleets transporting waste to the landfill. Apart from that, previous studies also stated that one of the problems in operating landfills was lack of labour (Lastari, 2017, Wirasaputra 2006). It means we need to have enough number of staff to operate the landfill and maintain the facilities. The human resources development would arise at various levels, at different times, and for various reasons such as demands from public policy and predetermined strategic planning or management. Lack of land to for a landfill is supported by previous study that shown it was problem that frequently happened in the city (Rainda, 2017). Limited of land, especially in building infrastructure facilities and infrastructure that supported public services such as landfills, was something that is always encountered. For lack of heavy equipment, where will brought the issue to improve the quality of the landfill such as the problem of roads that were still muddy and inadequate, especially when the weather was like often rains, even though maintenance was carried out (Fatroni, 2019). This study also found that lack of heavy equipment to break down the piles of waste at the landfill site also one of the problem during waste operation process.

4.3 Challenges on Ganet Landfill that Affect the Surrounding Environment

Every landfill would do the improvement for having the better operation, but the challenges were not easy to handle even the improvement was applied. The study found that, the challenges started from the landfill that was not have adequate facilities, the number of workers and equipment was insufficient, to the weather that was not supportive but still carried out processes or operations on the landfill. Additionally, Ganet landfill was a controlled landfill that performed slighty less well than the sanitary landfill to protect the surrounding natural environment. The challenges of Ganet landfill as a controlled landfill can be seen from Fig. 3., From 2008 until 2014, the landfill was run as a controlled landfill. Then, from 2015 to 2018, the landfill was upgraded to the sanitary landfill, but in 2018 the operational of landfill was back to the controlled landfill.

The first challenges identified by respondents were to expand the knowledge of the landfill to other workers and the community. Many people were ignorant of the information relevant to controlled landfill operations, sanitary landfill operations, innovations and landfill technology. Often the workers were not fully aware of the process and techniques of the landfill. To have a strong partnership and collaboration between them the workers and community had to know about the process, service, and technology of the landfill. The another challenges was the difficulties in improving the skills of workers with new technologies. The technological innovations were variants that began from heavy machinery, computer administration to gas utilization. Landfill site workers had to acquire more expertise to develop the confidence to consider the changes. Through giving the seminars and training each year provided by the government to help the workers to more understanding about the landfill operation is not enough.

The study shown that, the Ganet Landfill was the only landfill facility in the city of Tanjungpinang, Kepulauan Riau, Indonesia with about two hundred and twenty thousand (220,000) populations, it was impossible for Ganet Landfill to meet the satisfy the needs of population. For now and in the future, the landfill would have had to handle waste from civilization. There were a number of facilities that required more temporary shelter to be fulfilled, waste facilities according to its form, additional crew or workers to collect the waste from the shelter, and to serve the appropriate land for the future. It was not easy to face all those obstacles. It take time with proper master local plan and the financial support to complete it. In addition, one that made it more difficult to satisfy the needs of society was the shortage of facilities for the landfill. The small amount of machinery allowed the landfill to run slower than most landfills. With only two bulldozers, one loader and one excavator were not adequate to successfully run the landfill. At the same time, only one methane gas production plant operated. For all these weaknesses, the landfill still continue to operate and serve the neighborhood desires. The covering waste process was still carried out with limited equipment, while the current bulldozers were destroyed. The operation of the landfill did not stop by all of this; they only slowed down the operation and pushed workers to find the alternative solutions.

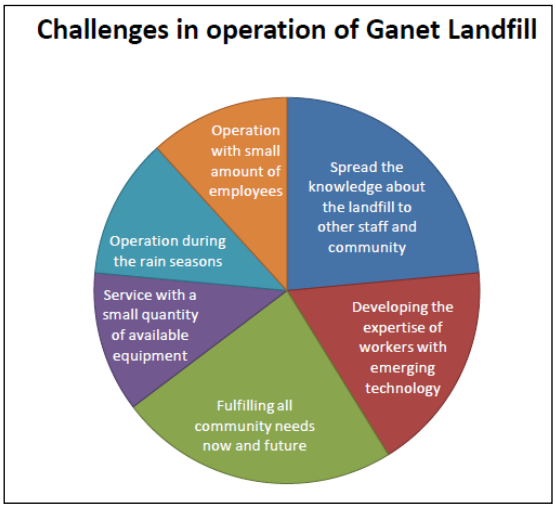

Fig. 3 - Main challenges in Ganet Landfill

The feedback from the respondents where even in the raining time and with the least number of workers, the landfill still needed to be operated. As the respondents highlighted before, there was a problem with road access to the unloading point at the landfill site. It happened when rainy season. The road was slippery and uneven to be passed by lorry and other heavy vehicles. Besides, when the rain was coming, the process of covering the pile of the waste was stopped caused the soil used was clay soil that could not be spread over the waste. Apart from that, landfill activities must continue. The landfill still had to receive the waste and unloaded it. The process of receiving waste could not be stopped caused by the road access. Therefore, that, the zone or the point to be unloaded were moved over until the rain was stop and the road could be passed. In addition, the soil covered process had to be done before more and more garbage was piled up and endangers the surrounding environment. Like the small number of workers, it was also important to pass and survive

the process of the landfill. When there were national holidays, where the waste multiplies enough that the current employees wanted to work overtime, the shortage of workers was felt.

One of the challenges in landfill is transferring knowledge from one agent to another, communication, exchange and conversion was quite low (Suryani, 2005). It also stated that knowledge transfer was the activity phase with the smallest percentage. This could be seen from the lack of activities in the form of socialization both internally in the company and to the community regarding waste management. In addition, socialization facilities and information media had indeed been made, but there had not been any activity of disseminating such information to the public or agents within the company. Nowadays, modern landfill had many technologies applied. One of them was the converting methane gas into something useable such as electric or fuel. This technology needed the knowledge workers (Eisberg, 2014). As several municipalities in Asia, the huge problem of growing quantities of solid waste along with insufficient landfill facilities, technological expertise and legislation had been discussed (Mclntyre, 2017).

4.4 The Improvements and Innovations for Ganet Landfill as Controlled Landfill

The development of technological advances in the field of waste management must be paid more attention because waste volumn was increasing over the time. Technology could be applied to overcome the problems and improve the landfill. Ganet Landfill as the only one landfill in Tanjungpinang needed to improve it from many aspects. Respondents agreed that it started from the process of the staffing at workplace. The process of controlled landfill consists the step of collected, unloaded, and covered. During operation process, the landfill had to consider the effect given to environment by using current design, equipments, and procedures. The respondents said that the technologies could be more beneficial if extended to how to handle the waste. Waste treatment technology was the most tried to seek in this sector. That may be the way in which the waste is handled, the processes or phases of the landfill operation and the design of the landfill itself. Ganet landfill was established in 1992 as an open dumping site, but converted to a controlled landfill site in 2008 and continued to function as a sanitary landfill site from 2012 to 2018 and now is back to the controlled landfill site since 2018. Respondents argued that the equipment of the landfill they learned was the incinerator, which would typically be used for medical waste. Incinerator technology was brought to them from a seminar given by the government to renovate the property that had been used. Incinerator technology may give land to be used for burying waste without the need for new land to serve.The old buried waste would be digged, and the excavation of the waste would be sieved, so that only the soil would remain for use while the waste would be burned in the machine.

In addition, Respondents 1, 2 and 3 as landfill workers were advised that one of the changes or remedies introduced to the landfill was to change the landfill zone during the rainy season. The rainy season would find the path to the point of unloading the waste muddy and impossible to get across. It was caused by a lane that had not been concreted or coated by tar. The thing that workers had always done is to change the waste discharge zone. While the respondent 4 as government employees said that the way they were helping to boost the operation of the landfill and solve the swelling of the amount of waste produced was by adjusting the waste collection schedule. It shifted from once a day for waste disposal to two to three times a day. The government also issued a different-colored garbage container to distinguish the waste from its sources to the public. But it wasn't really effective. All respondents agreed that the culture had to be helped in order to alter or implement the innovations, changes and technology relevant to landfills. Culture had revealed how the traditions of the local population or society had lived their daily lives and handled their waste. Respondent fourth said that a culture and a shift in the community's way of thinking about waste would also improve the productivity of landfill technology and development. If there were new technologies or changes in how to handle waste, but there was no general interest, it would not be worth it.

Although respondents 1 and 3 said that government funding was required to better upgrade the landfill. It was reported that the Ganet landfill was once a sanitary landfill, but reverted to the controlled landfill system because the funds held by the local authority were inadequate to continue enforcing the sanitary landfill method. As a result, the funds or fees given by the government became very necessary to improve the production of landfills for the better. Respondent 4 said that collaboration with the private sector must be addressed in order to develop and address the needs of the population. Table 7 shows the comparison of the propose improvement with previous study.

Table 71 - Comparison improvement on operation of landfill with previous study

Propose technologies for Ganet landfill	Previous study technologies used	
	Technologies	**References**
Changing from controlled landfill to sanitary landfill	Changing from open dumping to sanitary landfill	Planning of Final Disposal Site Using The Sanitary Landfill Method (Rijalurrahman, 2017)

Cooperation with private sectors	Involved the investors in contruction and operation of landfill	Strategies of Final Disposal Site (TPA) Management of Bantargebang, Bekasi (Winahyu, Hartoyo, & Syaukat, 2019)
The process of improving the waste operation is started from household	Increasing the recycle process from household	Study of Waste Management and Environmenta Impact Problems in Final Disposal Site (TPA)(Mahyudin, 2017)
Increasing the society, community, and public concern about the landfill	Promoting social participation and promoting the quality of human resources	Strategies of Final Disposal Site (TPA) Management of Bantargebang, Bekasi (Winahyu et al., 2019)

5. Conclusions

In conclusion, Ganet Landfill as a controlled landfill still had a lot of problems and challenges. The study shown most dominant current problem in Ganet landfill was lack of manpower, lack of heavy equipment, lack of land for the future, lack of infrastructure leading to unloading points, waste that was not put in its path, and lack of gas processing equipment. The challenges on Ganet Landfill affec the surrounding environments are operation with small amount of employee, sprad the knowledge about the landfill among staff and community, developing the expertise of workers with emerging tehcnologies, fulfilling all community needs now and the future, service with asmall quantity of available equipment and operation during rain seasons. While for innovations and improvement of technologies, where Ganet landfill need to change from the controlled landfill to the sanitary landfill, cooperation with private sector to improve the landfill service and maitainance, increase waste processing from household to the landfill, and increase community concern about landfill. With that, the Ganet Landfill could become a better landfill site in the future in the context of sustainable development at the local perspective.

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