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Municipal Solid Waste Management in Brunei Darussalam: A Sociology of Law Perspective

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ABSTRACT

Recently, municipal solid waste management becomes one of the major issues that have been taken seriously by Brunei Government since it has some implication with regards to safety, property values, quality of life, environment, social, and economic. Improper waste management will surely have a devastating effect on human being thus the country itself. This paper begins with the general overview of municiapal solid waste by surveying the definition. The second part presents state of solid waste management. The finding showed an indication that the number of municipal solid waste in Brunei Darussalam has increased. Thirdly, we examine how Brunei Darussalam municipal solid waste is managed, which include how it structure, collected, disposed and who is responsible for each section of the structure. Finally, we use sociology of law persepective to analyze the municipal solid waste management and explore some ways can be done to improve municipal solid waste management in Brunei Darussalam.

Keywords: **Municipal solid waste, sociology of law persective.**

1. INTRODUCTION

Solid waste Management is one of the major issues that have been taken seriously by most countries around the world since it has importance impact on environment, social and economic implication. Improper waste management will also has a devastating effect on human being, animal, fauna-flora and natural resources such as water and fresh air.

In Brunei Darussalam, one of the key challenges of urban development and growing population is focusing on the management and disposal of municipal solid waste since there is not many industrial wastes. Municipal solid waste is seen as primarily coming from households but also includes wastes from offices, commercial businesses, small scale industries or home industries and educational institutions. The major types of municipal solid waste are food wastes, paper, plastic, metal and glass, with some hazardous household wastes such as electric light bulbs, batteries, discarded medicines and automotive parts.

2. DEFINITION MUNICIPAL SOLID WASTE AND MANAGEMENT

Solid waste is all the wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted (garbage, refuse and sludge). Another definition of solid waste as "a collective term for garbage, refuse, rubbish, and trash, each term representing a definite category of solid-waste materials according to the classification.

Municipal solid waste (MSW) is a waste type that includes predominantly household waste

(domestic waste) with sometimes the addition of commercial wastes collected by a municipality within a given area. There are either solid or semi solid form and generally exclude industrial hazardous wastes [1].

The legal and regulatory definition of "solid waste" is very broad. In addition to residential trash, commonly known as "municipal solid waste" (MSW"), the term also includes wastes generated by restaurants, office buildings and similar business establishments ("commercial waste"), manufacturing companies and wastewater treatment plants ("industrial waste"), and waste generated by building or tearing down buildings and other structures ("construction and demolition debris", also known as "C&D waste"). Even hazardous and medical wastes are considered to be solid wastes, but they are more strictly regulated by federal agencies and the states. Technically, solid waste goes beyond those kinds of wastes to include any solid, liquid, or contained gaseous material that is discarded by being disposed of, incinerated, or recycled [2].

Waste management is literally the process of managing waste materials of which majority resulted from human activities [wikipedia]. Managing solid waste begins by collection and followed by disposal. Typical composition of solid waste has been: wood waste; paper; cardboard; rubber/leather; cloths; gravel; stones; metal; boxes and many more [3]. One of the challenges is faced by government is to maintain a clean and healthy environment for the people. In this world of rapid urbanization, the issue of how to manage the solid waste effectively is still continues to be a major priority of all government, including Brunei Darussalam.

3. THE PRESENT STATE OF MUNICIPAL SOLID WASTE MANAGEMENT IN BRUNEI

Figure 1. Municipal Solid Waste in ASEAN Countries

ASEAN Country	**Municipal solid waste (kg per capita per day) in 2001**
Singapore	1.86
Brunei DArussalam	1.4
Thailand	1.0 (urban areas)
Lao PDR	0.75
Malaysia	0.68
Vietnam	0.61
Philippines	0.5 (urban areas); 0.3 (rural areas)

[Source: ASEAN, 2006]

Brunei Darussalam is one of prosperous countries on the world with GDP percapita 32,501 US$ in 2007 and the topopulation of approximately 378,000 peopple in 2007 [4]. Brunei's average waste per capita is 1.4kg per day and most of MSW from the waste products that is sent to Sungai Akar yearly, 41% are recyclable products consisting of paper, metal and glass while another 36% are food waste and 5% are yard waste which can be composted instead of thrown in the landfill area [5]. Brunei is the second highest of was producer for muinicipal solid waste per kg, per capita and perday in ASEAN countries after Singapore as seen in the Figure 1. With modern lifestyle, materials used become more complex and tend to increase in volume and varieties. Lately, domestic households are disposing more hazardous and toxic wastes into municipal waste. Such includes waste paints, flammable solvents, caustic cleaners, batteries and mercury from broken thermometers.

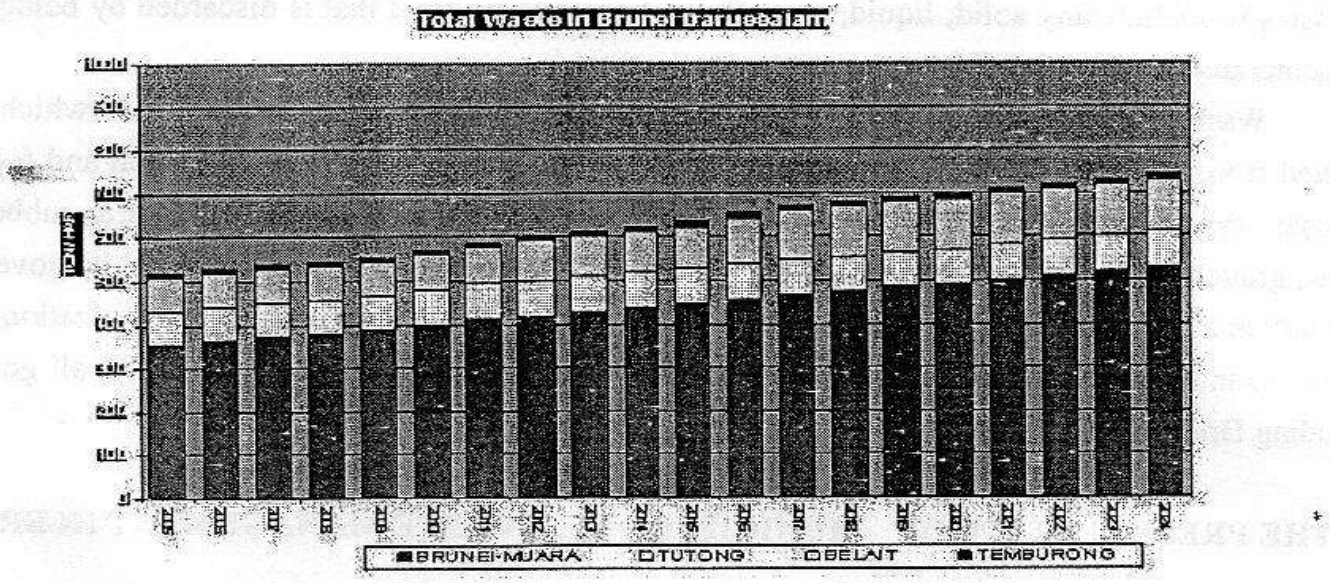
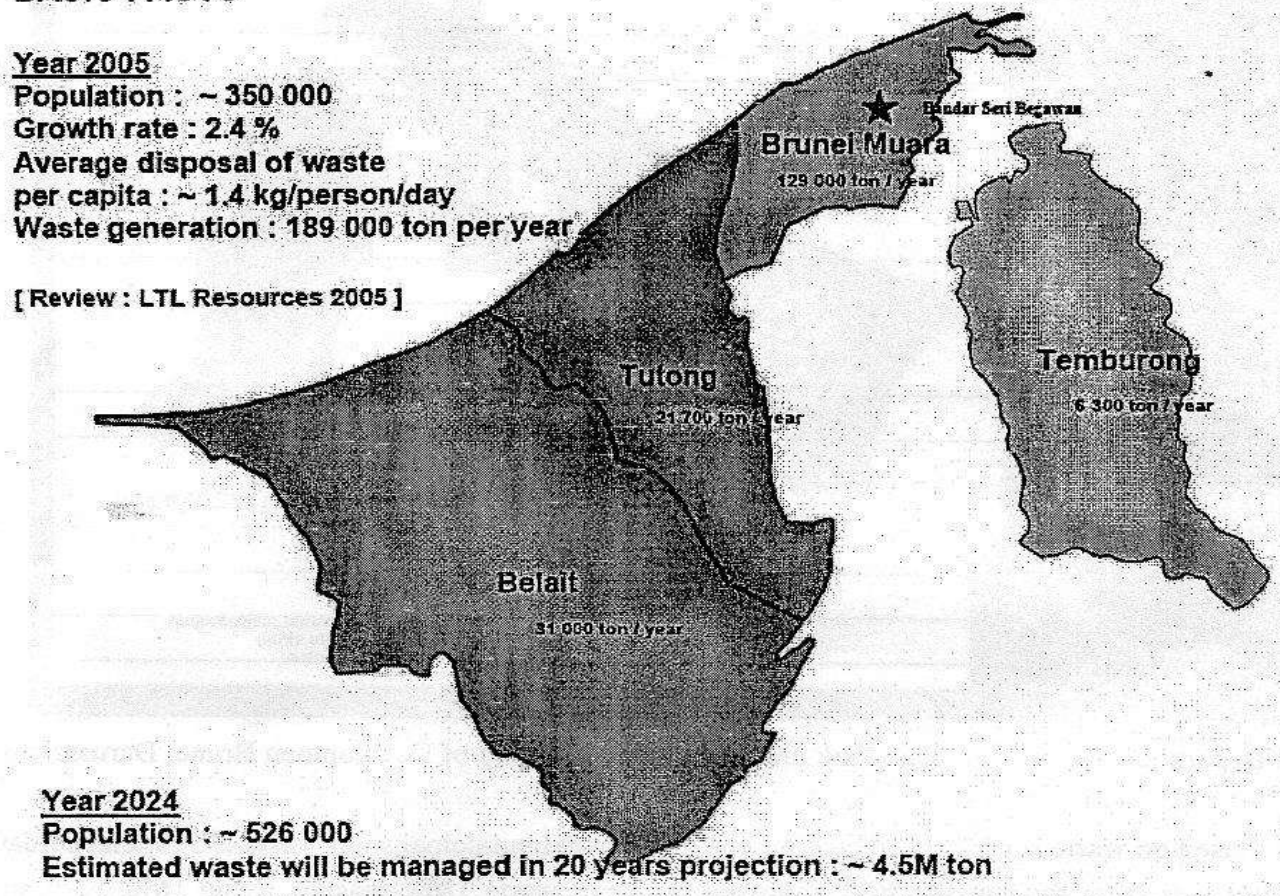


Figure 2 municipal solid waste per year (Source: Department of Environment, Park and Recreation, Ministry of Development, Brunei Darussalam)

According Departement of to Environment and Recreation, Ministry of Development Brunei Darussalam, the population generates of 189,000 tones for municipal solid waste per year (Figure 2).

The community in Brunei–Muara District which locates in the capital city as well as center of urban generates about 353 tons of municipal solid waste per day. While other district such as Tutong District with 59 tons perday, Kuala Belait District about 84 tons perday and Temburong District with 17 tons perday. The total number of municipal solid waste in Brunei Darussalam is 513 tons perday (Map 1).

Map 1 **Distribution of Municipal Solid Waste in Brunei Darussalam**



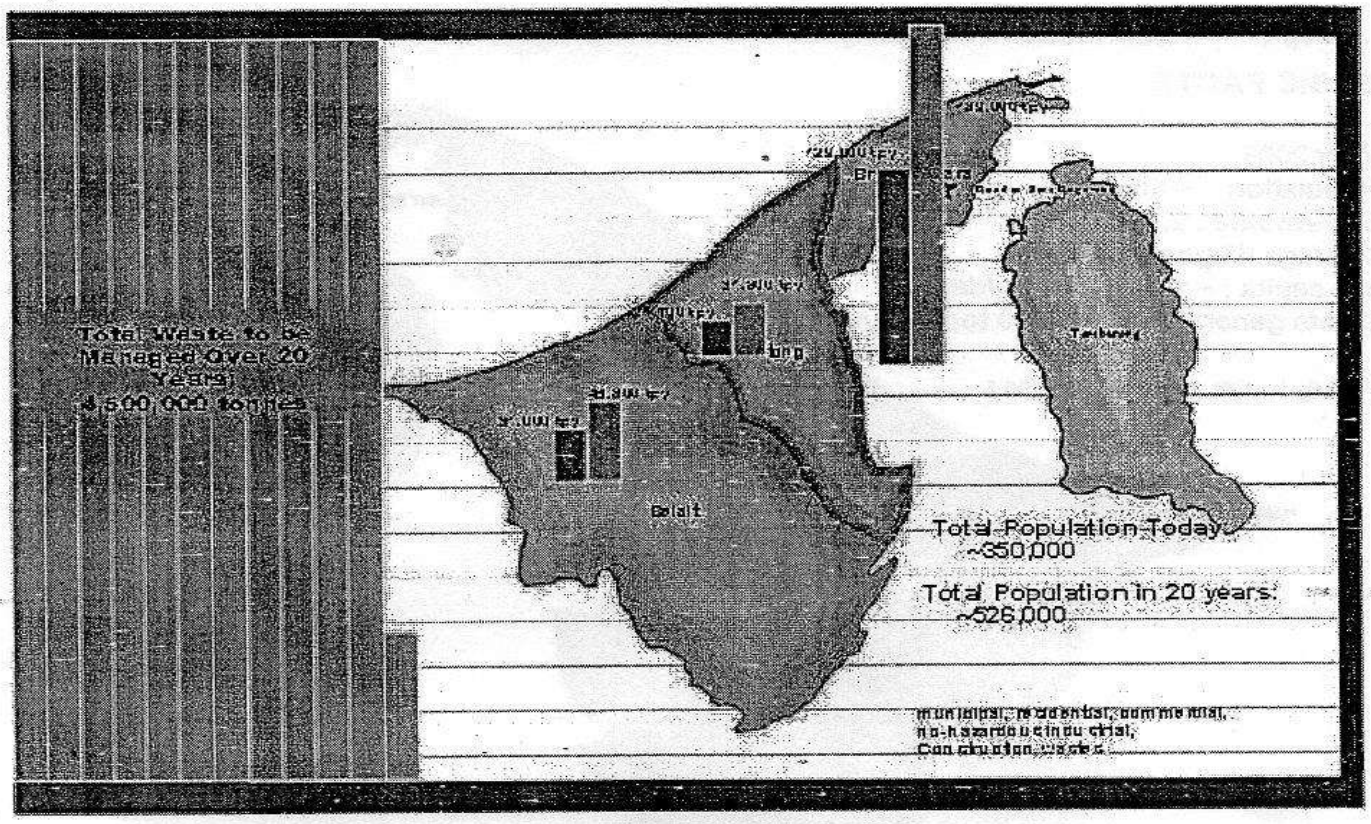
Source: Department of Environment, Park and Recreation, Ministry of Development, Brunei Darussalam

With growth rate of municipal solid waste in Brunei Darussalam is approximately 2.4 %, each person can generate approximately 1.4 kg per day and with the total estimation population is 526,000 people along with the process urbanization, it is estimated that in next twenty years later (2024) the total amount of of municipal solid waste will be around 4.5 million tons per year (Map 2).

Waste generation in Brunei Darussalam consists of:

i. Residential [including single-family homes, apartments, flats etc]
ii. Commercial [including shops, offices, restaurants, markets, banks etc.]
iii. Instutional [including schools, hospitals, government offices etc.]
iv. Industrial [including food processing plants, factories, warehouses etc]
v. Others waste stream [Soil; Construction waste; Hazardous waste; Waste oil]

Map 2 **Estimation of Municipal Solid Waste in 2024**



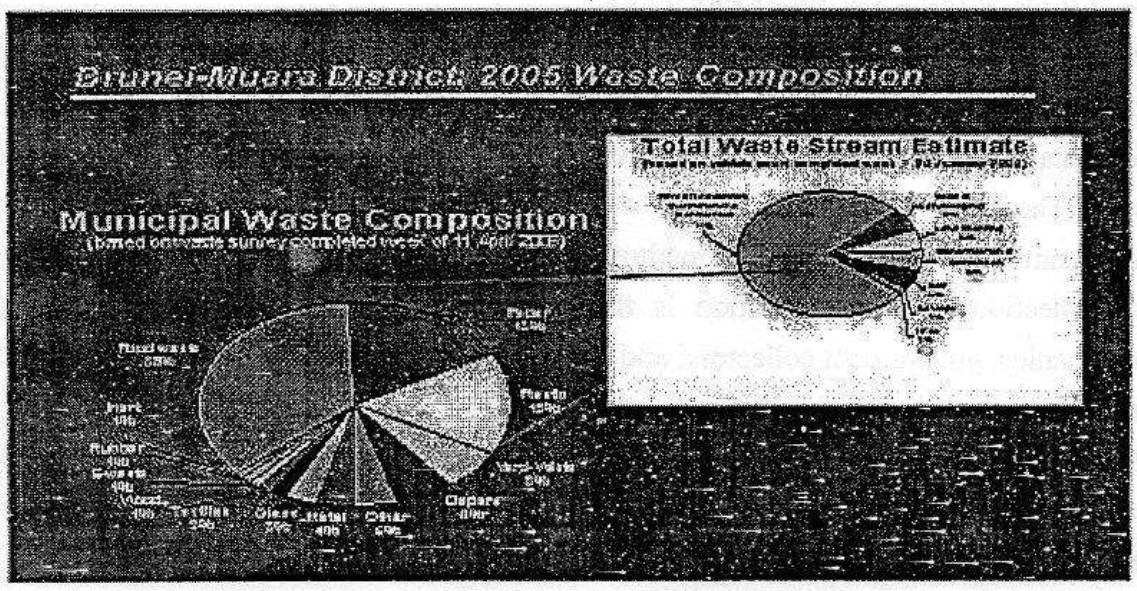
Source: Department of Environment, Park and Recreation, Ministry of Developmen Brunei Darussalam

Based on waste survey completed in April 2005, total municipal solid waste is 513 tons perday, the biggest was from food waste 36%, followed by paper waste 18%, plastics waste 16%, yard and diapers fall to 6% each, other waste 5%, metal waste 4% glass waste 3%, textiles waste 2 %, wood, e-waste, rubber and inert waste is 1% respectively (Chart 1).

Total waste stream estimated in January 2007 that 77% of the waste come from mixed residential, institutional and commercial (Chart1).

In Brunei Darussalam most of the waste mentioned above, end up at the landfill site/dumpsite. There are six municipal solid waste landfill sites in Brunei. One main and major landfill site is the Sungai Akar landfill site in Brunei-Muara District. Sungai Akar dumpsite began its operation in 1987 catered only for solid wastes disposal within the Brunei Muara district. The landfill was designated to be used for not more than 10 years. However, it has been more than 15 years and the dumpsite is still under operations. The dumping site has encroached beyond its designated area, creating a danger of leachete and contamination of groundwater. Sg Akar dumpsite is not an engineered purpose built landfill (Picture 2).

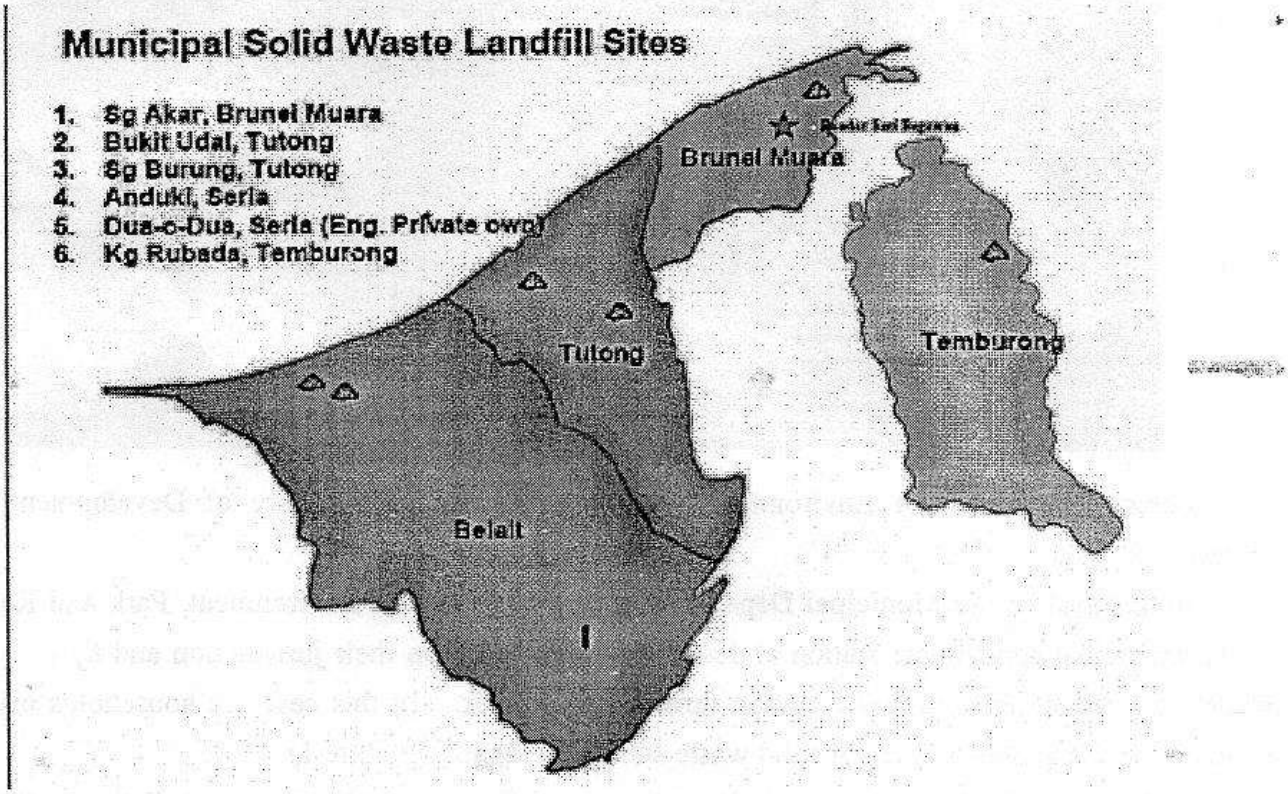
Chart 1 **Municipal Solid Waste Waste Composition in Brunei 2005**



Source: Department of Environment, Park and Recreation, Ministry of Development, Brunei Darussalam

In addition, there are two landfills in Tutong District namely Bukit Udal landfill and Sungai Burung. There are also two minor landfills at Anduki and Dua-o-Dua in Seria and one major landfill is located in Kg Rubada, Temburong District (Map 3).

Map 3 **Existing Municipal Landfill in Brunei Darussalam**



Source: Department of Environment, Park and Recreation, Ministry of Development, Brunei Darussalam

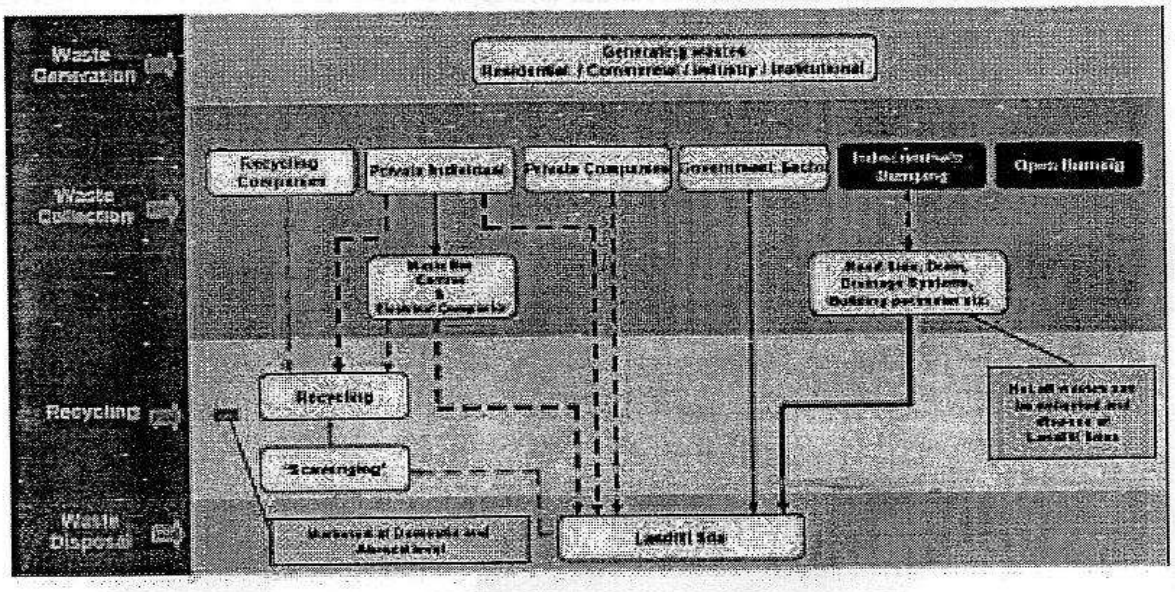
4. MUNICIPAL SOLID WASTE MANAGEMENT IN BRUNEI FROM SOCIOLOGY OF LAW PERSPECTIVE

Brunei Darussalam like many other countries on the world tries to manage its municipal solid waste as good as possible according to world standard municipal solid waste management. There are some stages in managing municipal solid waste such as waste generation, waste collection, recycling and waste disposal. The first stage is to devide the waste generation through some waste producers such as residentials, commercials, industries and institutional. The next stage of management is municipal solid waste collection. Waste collection is through individual disposal; registered private waste collecting companies; government collectors; and unregistered private collecting waste companies

In this stage, thre are some parties involve in collecting the waste. In Brunei Muara District, from the year 1990, disposal site has been managed by Municipal Department of Ministry of Home Affairs. The department was also responsible for the collection or refine generated within and those areas 6km outside the Municipal Department.

Most of the waste collection is done by the Municipal Department according to their jurisdiction. Since 2003, the Department of Environment, Park, and Recreation [6], Ministry of Development was formed and has task to collect the municipal solid waste together with Municipal Department (Chart 2).

Chart 2. **Municipal Solid Waste Management in Brunei**



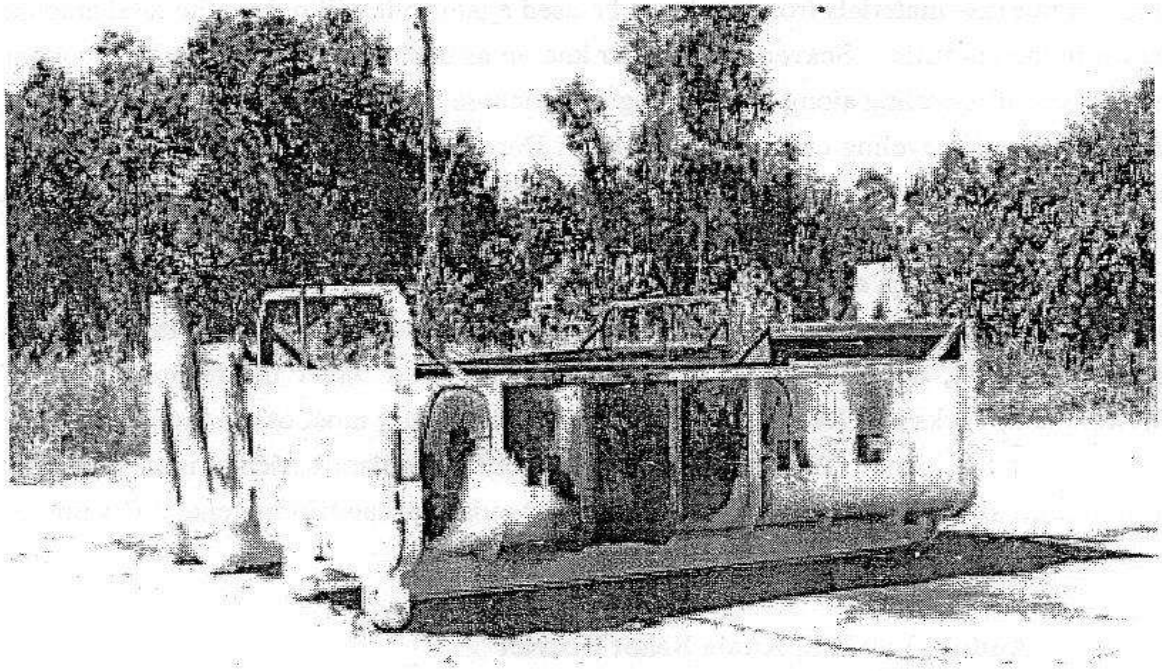
Source: Department of Environment, Park and Recreation, Ministry of Development, Brunei Darussalam

In this system the Municipal Department and Department of Environment, Park and Recreation set up municipal solid waste station at designated area based on their jurisdiction and they collect the waste from the designated waste station three times a week. In this case the households bring their waste to the designated municipal solid waste station (self haul) (Picture 1).

In addition to the both Municipal Government and Department Environment, Park and Recreation waste collection, there are some private companies involve in collecting the municipal solid waste in Brunei Darussalam. These private companies will collect the municipal solid waste from door to door in

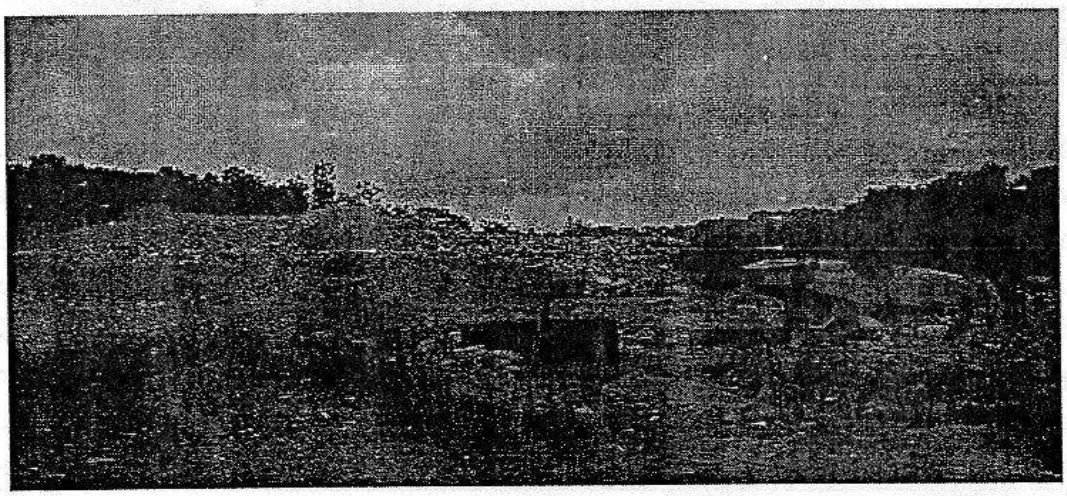
Brunei Muara and Kampung Air. In return the households have to pay B$20 per month to the private company (Door to door collection).

Picture 1 **Designated Waste Station in Brunei Muara District**



There are also registered and approved haulers in Brunei Muara, commercial property and light industrial areas in Brunei Darussalam. Moreover, there are some waste collection centers for certain materials such as electrical compactors in Brunei Muara District, communal skips and bins in Tutong District, communal bin in Temburong District, and and communal skips in Seria and Kuala Belait District. The distribution of hauler consists of 26% public sector haulers, 34% registered and approved haulers and 40% unregistered hauler including self haul.

Picture 2 **Sungai Akar Lanfill, Brunei Muara District**



The third stage of management is the recycling process. Brunei Darussalam government promotes recycling but in the smaller scale. Some places have now being introduce with recycling bins, where different bins are being located for different material such as glass bin, paper bin and also aluminium bin. Recycle is considered very important in the management of municipal solid waste in Brunei Darussalam. Since raw materials from trash can be used again so it will reduce the total amount of waste to be thrown in the landfills. Scavenger or better known as trash pickers are usually important people that aid the process of recycling along with getting side income from the sale of raw materials.

There are some metal recycling companies in Brunei Darussalam such as Metussin Recycling, Perindustrial dan Perkembangan Pemotongan Syarikat dan Memasak Besi and Sallima Recycling Works. Metussin Recycling recycles waste paper, cardboard and plastic. Others recycle waste bins at compactor sites, reuse of construction waste such as concrete and bricks for road base.

The most important part of municipal solid waste management stage is the stage of final disposal. As of January 2004, dumpsite/landfill management has been under the responsibility of Department of Environment, Parks and Recreations. In Brunei Darussalam, most of the municipal solid waste will end up at the landfills side. The landfill site in Brunei Darussalam basically is a dump site. Unfortunately all of landfill sites do not meet the international standard of landfill in general (Picture 2, and 3).

Picture 3 **Anduki Landfill, Kuala Belait District**

In Brunei, landfill/disposal sites type is a very simple type. Wastes are placed in the landfill and then covered with a layer of soil at the end of the day. Dumping rubbish into landfill sites is a common method, simple and low cost. This type of landfill is only required flat land area to dump the municipal solid waste. This type of landfill is suitable for small quantity collection of waste and can only be convenient for temporary use.

Improper disposal of municipal solid waste will create negative impacts on the environment and human being. It can cause severe aesthetic nuisance in terms of smell and appearance. It also polluted water flowing from waste dumps and disposal sites. Moreover, it can cause serious pollution of water

supplies, spread of diseases (from flies, mosquitoes, rats), can create hazardous air pollution and damage quality of environment.

Dispose municipal solid waste in the landfill is unsustainable management of environment, it posses threats to people and also the flora and fauna and animals of those living near landfill areas. Improper landfill will cause some problems such as environment, social and cultural aspect, economic aspect and infrastructure.

Landfills are open areas of ground, generally natural pits or hollows, where rubbish has simply been dumped. When the site is full, earth is bulldozed over the top and the area left to settle, or the landfill was simply left as it was as an eyesore and health hazard.

Other problems associated with landfills are high water table, groundwater contamination and methane gas production from organic waste, as well as other gases, which are generally responsible for the odor level of surrounding a landfill site. Over ten toxic gases are released from landfills especially the toxic gas of methane gas. Until the landfill site has settled and the gas production has died down there is no way of reclaiming the land for building purposes, although the planting of trees and grass is possible in the short-term. The production of gas will probably continue for around 20 to 30 years in many cases from a landfill site, with a gradual reduction after about 10 years.

Landfills present a clear and potential threat to human health and our environment. As noted even the best landfill liners will probably leak. Bottom liner can be formed through layers of clay or a synthetic flexible membrane (or a combination of these). The liner effectively creates a bathtub in the ground. If the bottom liner fails, wastes will migrate directly into surrounding the environment.

There are three types of liners: clay, plastic, and composite. Natural clay is often fractured and cracked. A mechanism called diffusion will move organic chemicals like benzene through a three-foot thick clay landfill liner in approximately five years. Some chemicals can degrade clay.

The very best landfill liners today are made of a tough plastic film called high density polyethylene (HDPE). A number of household chemicals will degrade HDPE, permeating it (passing through it), making it lose its strength, softening it, or making it become brittle and crack. Not only will household chemicals, such as moth balls, degrade HDPE, but much more things can cause it to develop stress cracks, such as, margarine, vinegar, ethyl alcohol (booze), shoe polish, peppermint oil, to name a few.

A Composite liner is a single liner made of two parts, a plastic liner and compacted soil (usually clay soil). All plastic liners (also called Flexible Membrane Liners or FMLs) will have some leaks. It is important to realize that all materials used as liners are at least slightly permeable to liquids or gases and a certain amount of penetration through liners should be expected. Additional leakage results from defects such as cracks, holes, and faulty seams. Studies show that a 10-acre landfill will have a leak rate somewhere between 0.2 and 10 gallons per day. This is an alarming statistic considering that in addition to leakage, landfills also provide problems to our health and environment through hazardous contaminated air emissions.

In Brunei, the landfill area at Sungai Akar does not even have any sort of bottom liners. The rubbish just keeps on piling one after another per day and for sure there are all sorts of potential hazard

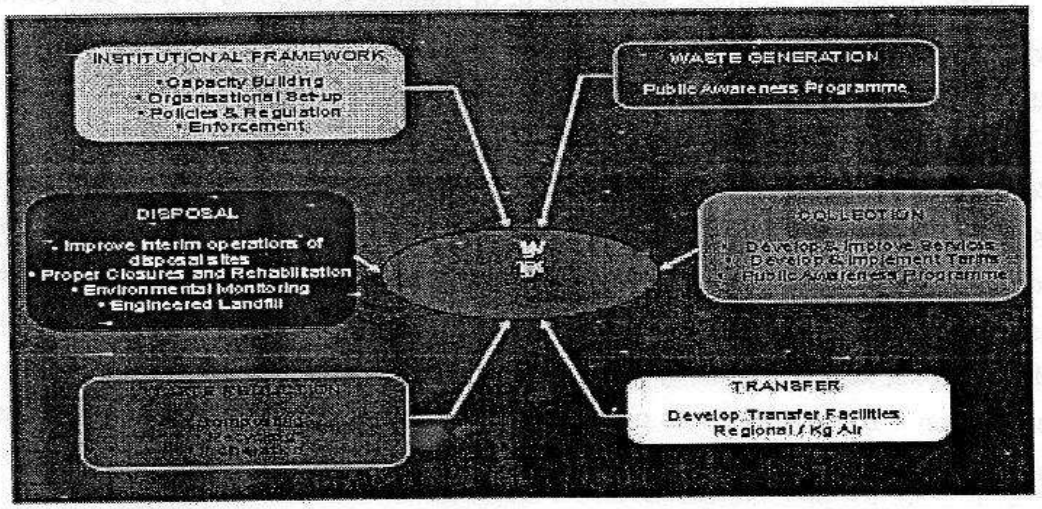
leakage occurring, we cannot even capture the methane gas that is emitted from this landfill area due to its current condition.

In Brunei, dumping sites are allocated at designated zones, sometimes one can find waste station sites where the population living in the area is quite high. Due to the easy accessibility of the waste station site, Bruneians are not thinking of other ways to dispose off their waste. Besides, most Bruneians are not even expose to other ways of waste disposal, and if they are exposed, some of them are not even been taught properly. For instance, one can see in some institutions they have the recycling bins around their compound, but if one were to look how the waste is sorted, sometimes it is not even sorted in accordance to the bins, i.e. plastic, paper and glass.

Collection and transportation are highly labor and capital intensive, by door-to-door or using containers and communal bins. [7] The government spends $6 for every ton of rubbish to transport and dispose the rubbish to landfill areas. This means the government is paying more than a million dollar per year just to collect and dispose of the waste. [8].

One of the main goals of Brunei's government is to provide it'speople to enjoy a clean and healthy environment. The government has made a considerable progress to incorporate the environmental concern into development planning. The concern for environmental conservation and management for Brunei started in the 5th NDP and repeated in the 6th, 7th and 8th. Brunei government is really concern on municipal solid waste disposal management. The government tries to maintain and improve the available municipal solid waste system management. The main issue is how to manage the solid waste effectively and efficiently is still continues to be a major issues an become a priority of the government. The Brunei government aims to have "an integrated solid waste management (Chart 3)." It is involve in identifying a suitable landfill site to cater solid waste in Brunei- Muara and also Tutong District. Other project involves with expanding and improving the current dumping site in Anduki to cater solid waste and in Belait District.

Chart 3 **Integrated Solid Waste Management**



Unfortunately up to now, the institutional framework submitted by the government still has loopholes such as administration, legislation and public awareness. In administration it includes many stake holders:

i. Municipal Board;
ii. Public Wirk Department;
iii. District Office;
iv. Other Government Departments.

The problem is which administrative authority and responsibility in handling the municipal solid waste. This problem is being consolidated and in the process of transition.

The government has made a lot of efforts to improve the municipal solid waste management by setting out the budgets to provide for managing municipal solid waste. The amount of budgets has been set up for the preparation and improvement of proper waste management system in Brunei Muara District with B$ 252,000 per one year, Kuala Belait District with B$ 97,200 per one year, Tutong District with B$306,608.90 per two years and Temburong District with 369,621 per 3 year (Table 1).

Table 1 **Budget for Municipal Solid Waste**

Districts	Cost	Duration	Budget
Brunei Muara	B$ 2,450,000	16 months	B$252,000/ 1year
Kuala Belait	B$1,531,000	16 months	B$97,200/1year
Tutong			B$306,680.90/2years
Temburong			B$369,621/3years

Source: DEPR

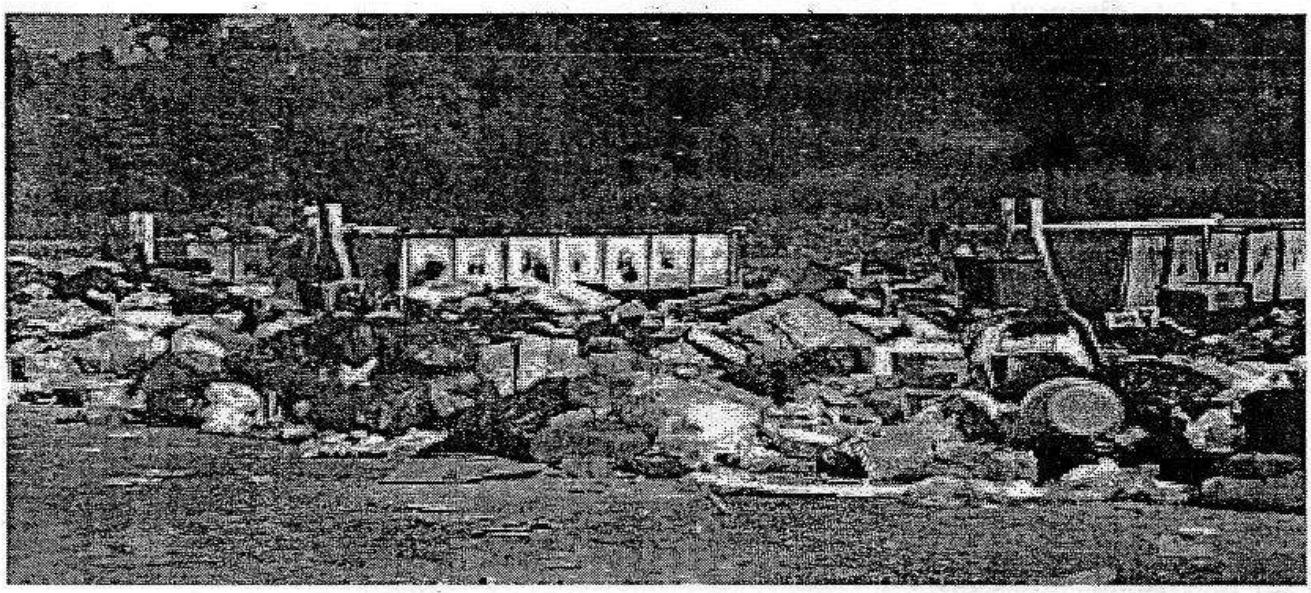
The aim for those budgets is to improve and develop all municipal solid waste management in Brunei Darussalam in terms of efficiency and effectiveness from waste generation, waste collection, waste recycling and waste disposal.

However, increasing the budget for municipal solid waste management will not solve the problem by itself. There are some aspects that we have to consider in order to copewith the municipal solid waste management issues such as legislation and enforcement, public awareness, and other solutions such as promoting refuse, source reduction, reuse, recycling program, composting and incineration.

There is no significant regulation on municipal solid waste management in Brunei Darussalam. There is only the Minor Offences Act (Amendment) Order 2006 and the Minor Offences (Method and Procedure of Compounding) Rules 2006 that have been enforced since October 12, 2006 [9]. The Section 12 (1) (a) of the Minor Offences Act Chapter 30 states that "any person who, places, deposits or throws any dust, dirt, paper, ash, carcass, refuse, box, barrel, bale or other articles in any public place can be fined $100 for individuals and $200 for other bodies. Section 12 (1) (b) states that "any person who, keeps or leaves any article of thing whatsoever in any place where it or particles there from have passed or are likely to pass into any public places" can be fined $100 or $200 for other bodies.

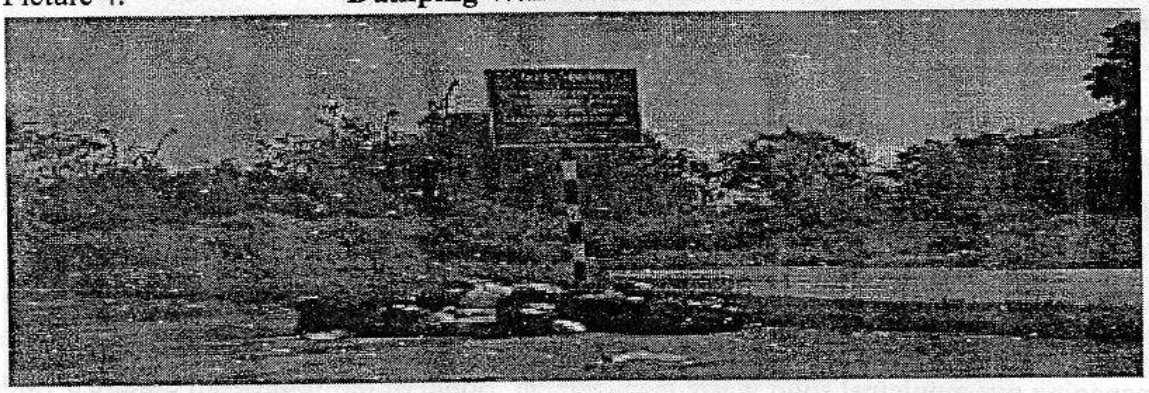
A $300 fine for individuals or $500 for other bodies awaits under Section (1) (c) for any person who throws, places, spills or scatters any blood, brine, swill, noxious liquid or other offensive or filthy matter of any kind in such manner as to run or fall into any public places. The same fine goes for Section 12 (1) (d) for any person who, drops, spills or scatters any dirt, sand, earth, gravel, clay, loam, stone, grass, straw, shavings, saw dust, ashes, garden refuse, stable refuse, trade refuse, manure, garbage or any thing or matter in any public place, whether from a moving or stationary vehicle in any other manner. Also providing for the same fine is Section 12 (1) (e) for any person who throws or leaves behind any bottle, glass, can, food container, food wrapper, particles of food or any other article or thing in any public spaces. The maximum fine of $500 for individuals or any other bodies comes under Section 12 (1) (f)(i) and Section 12 (1) (f)(ii) for those who without lawful authority, abandon, on any part of a road or on any land in the open air - "a vehicle" or "any other thing, being a thing which he has brought to the land for the purpose of abandoning it there". Under the Minor Offences (Method and Procedure of Compounding) Rules 2006, those that have been issued with a compound fine must pay it in cash within seven days. It was also mentioned that under this rule, a receipt will be issued after the compound payment has been made to the relevant authorities. Court action under Section 12 of the Minor Offences Act will be taken on those who fail to pay the compound fine and if found guilty, they can be fined $1,000 for the first offence and $3,000 and jailed not more than three months for the following offence. However up to now the implementation of Minor Offence Act is still weak. Since nobody is fined. It seems nobody relizes the existence of the act. Public awareness on proper municipal solid waste treatment is still a big problem in Brunei. Lack of public awareness will have an impact on the proper municipal solid waste management itself. Improper handling by the society will reduce the effectiveness of the facilities provided such as dispose the waste not in the waste station (Picture 3, 4, 5 and 6).

Picture 3. **Improper Use of Waste Station**



In term of public awareness, Brunei Government has to instill program that can stimulate society to aware the danger of improper treatment of municipal solid waste through Friday sermon, intra village competition for the proper waste treatment and give reward to the head of village (kampong). In addition the children should be educated in school from kindy to university level about a clean and healthy environment. This will include the need of a clean environment in their civic studies. Brunei government also needs comprehensive and effective set of regulation, and standards on municipal solid waste management. The regulation will make clear and solve the problem of administrative authority and responsibility as well as the responsibility and right of respective stake holders in municipal solid waste management. It is recommended that the authority should enforce the regulation, carry out frequent monitoring and inspection on improper dumping.

Picture 4. **Dumping Waste at Prohibited Site**



Picture 5 **Dumping Waste at Housing Site**

The benefits of incorporating the other solutions in addition to landfill are reduced waste generation, reduced landfill volumes, reduced anaerobic decomposed materials at landfills and hence extending the time use of landfills with reduced volume. Each potential solution is will be described below.

Picture 6. **Abandon Waste at Commercial Site**

Brunei government is recommended to carry out additional solutions to landfills. Landfill is the final disposal method after all other solutions has been done. The other solutions such as rethink, refuse, source reduction, reuse materials and products, recycling, composting and incineration [10].

a. Rethink

We need to encourage ourself and other people to rethink about the way we interact with environment. We need to re think this way and find a better ways of interacting with environment especially in managing our municipal solid waste management. Some of our traditional culture's values and belief can help us with this rethinking process. Ask our self some basic questions who are we, do we respect our mother earth. Are we creating a lot of waste in our lives? Polluting the environmemnt is not our way and littering is not our way.

b. Refuse

Refuse means we need to refuse some of the things that being offered to us for consumption. We are dominated by a throw-away society. When a product becomes outdated or old, we are encouraged to buy another 'new and improved' product, and throw the old one in the landfill site. We can refuse product that harm the environment or not eco-friendly product such as plastic, and product that CFC gas.

c. Reduce

Source reduction means using less material in the beginning of the packaging process and reduced volume of packaging materials that needs to be recycled or discarded after consumption. Consumers can reduce the burden of the pollution on the earth by purchasing products with less toxic materials, for instance product like aerosols, fertilizers, hair sprays and so forth. Consumers should choose eco-friendly products instead of buying the products because of its brand or because of the cheap price. Products that do not label themselves as eco-friendly will emit greenhouse gases into the atmosphere. Once used disposal of such materials without further destroying the environment would be difficult.

Educating people on using reusable item would greatly reduce the amount of waste. For instance, shoppers using own reusable grocery bag instead supermarket plastic bags, or bringing own food

containers for takeaways instead of the restaurant's styroform packaging.

When we start reducing, we also start to spend less. One way of saving money is to buy in bulk. When we buy in bulk, the amount of packaging is greatly reduced compared to purchasing goods in smaller quantity. Furthermore, it is cheaper to buy in large quantity.

Setting up a national waste reduction in Brunei darussalam would likely encourage the public to start to build up the habit of reducing waste. An integrated waste management system with the goal of 'zero waste' for all should be a cooperative effort by all stakeholders.

d. Reuse waste consumption

Reusing items, by repairing them, donating them to charity and community groups, or selling them, also reduces waste. Reusing products, where possible, is even better than recycling because the item does not need to be reprocessed before it can be used again [11].

Reusing items will decreases waste dramatically, which would eventually lead to less material needed to be recycled or sent to landfill areas or waste combustion facilities.

Reusing waste is practiced in the Brunei culture. We use durable coffee mugs instead of the polystyrene cups either at home or at the office. Bruneians reuse plastic bottles for drinking water or just for collecting tap water. During the hari raya season, empty jars are collected and used as containers for keeping biscuits. During non-festive season, the empty jars are used as containers for leftover foods. This way, their attitude will save space at the dumping site and also save money.

Reusing waste can also mean economic savings for communities, businesses and also individual consumers. There is a "pay-as-you-throw" program in United Kingdom, where they pay for each bag of trash they sent out for disposal rather than paying a flat fee rate monthly. This kind of program would act like an incentive for individual to throw less and try to implement other forms of waste disposal, such as, reusing the waste whenever appropriate [12]

Government should encourage the people to reuse their waste wherever appropriate. Setting up a specific location for the people to send in their waste to be reused by other people or allocating an area where the waste can be re fix should be available in the near future.

e. Recycling and Composting

Recycling and composting keeps organic wastes out of landfills, prevents emissions of greenhouse gases and water pollutants and reduces the need for new landfills and incinerators [13]. Recycling also has energy saving benefits. According to Aluminum Association and Earth 911 [14], recycled aluminum saves 95% energy than producing aluminum from ore, recycled paper saves 60% energy from new paper and recycled glass saves 50% energy from new glass. Producing of new materials emit greenhouse gases. Hence recycling saves energy and reduces greenhouse gas production. Composting reduces the need for fertilizers and pesticides.

Educating the public on how to separate and dispose of waste responsibly is the first step towards enabling recycling and waste minimization program. Such education includes:

i. Source separation: how to separate waste for further treatment or disposal

ii. Recycling: what is recyclable, where to bring such materials, i.e. recycling collection points, designated bins at common dumping areas, companies that can be contacted to collect recyclables; location of recycling companies

iii. Compost: what can be composted, how to do it at home, where are compost collection points, any companies that can be contacted to collect recyclables

iv. Wastes requiring special treatment such as waste oil, batteries and e-waste: where to bring for treatment, where are collection points

Much education needs to be done to change the mindset of Brunei people of which the majority is still negligent of proper waste disposal methods. Workshops and demonstrations of such methods can be done at road shows and through community encouragement and initiatives.

As the saying goes, one man's trash is another's treasure; recyclable materials also have values. Different type of waste have different price, for instance, paper is worth 3 cents per kg. A 'junk car' in Brunei is worth 20 cents per kg or approximately $200 per car [15]. Paying the public for recyclables incentivizes such habit instead of just throwing recyclables with 'zero earning' and also curb illegal dumping. Private waste collectors can also play its role in encouraging recycling of waste by offering to collect general waste with recyclables, or collect recyclables at specified times. Private collectors can pay their customers for the recyclables when collecting during their regular routing.

Recycling services can be expanded to cover more materials such as glass for expanded economic activity for the private sector and increased employment opportunities. In developed countries (Japan and Germany), it was observed that there are 5 times as many people employed in the recycling industry compared to the waste disposal industry, even though 3 times as much waste is handled by disposal [16].

Energy saved in recycling products into other forms also translates into economic savings. Good quality composts can be sold to farms or households for use in gardens.

Currently there are no regulations in place to enforce good practices of waste minimization and recycling in Brunei. Much more can be done to enforce this and is already practiced in other countries [17]. Only allow materials that cannot be recycled or composted to be disposed at landfill, mandatory source separation, mandatory recycling of recyclable materials, mandatory use of recycling bins in public areas, schools and offices, impose fines for illegal dumping, impose fines for open burning to encourage composting, paying waste by weight, giving incentives to households and companies who practice recycling or even zero waste and set national goals for waste minimization.

Currently, recycling bins at public disposal zones are household size instead of community size. The bins should be community size; so that the recyclable waste is not being left outside the bins once it is full. Recycling collection points should be allocated and set up in areas that are convenient for the public and can even be a storefront, school or community centre.

Private waste collecting companies can also provide basic information such as timing of collection of recyclables and composts so that all households can be aware of when to place such items outside of their premise for collection.

Recycling requires collaboration of local authorities to ensure the cleanliness of recycling

facilities and locations, and penalties imposed for illegal recycling of stolen public property.

f. Incineration

Incineration refers to the combustion of waste materials and can incorporate technology to generate power from the heat produced during combustion [18]. Incineration is being considered by DEPR as one of solution to waste reduction.

Incineration is popular in developed countries, especially where land is a scare resource, such as Singapore where 90% of non-recyclable solid waste is incinerated and remaining 10% is disposed at landfills [19]. Some believe that incineration is not sustainable because of greenhouse gas emissions, particulate matter and heavy metals from incinerators [20]. Some environmental laws impose limits on the use of incinerators [21].

Nevertheless, incineration is adopted by many developed countries [22] states that 'modern incinerators have advanced process control measures to ensure complete combustion, destroy all organic pollutants, prevent the production of new pollutants and can meet the most stringent international emission standards by using advanced gas cleaning and pollution abatement equipment.'

Burning of waste is commonly practiced in Brunei and likewise, incinerators could be easily accepted by Bruneians. However, with the use of incinerators, the general public may take it for granted to incinerate everything. This is a threat to developing recycling habits.

Incinerators require large costs to construct, operate and maintain, especially for good scrubber systems. Singapore's newest incineration plant with a capacity of 3000 tonnes/day was built at a cost of $900 million in 2000 [23]. Ideally, costs should be borne by the general public. Otherwise, the government may be required to absorb the cost.

It needs to be located away from residential area for sufficient buffer zone for air emission to mitigate away from residents. Incinerators will likely be operated by the private sector as the Brunei government does not have the expertise to run an incinerator. As such, payment to the operator will likely be by usage basis or lump sum by the user. This will also help with curbing illegal dumping at the landfill, as most materials should go to incinerators first and lastly to landfills.

5. CONCLUSION

Lack of public awareness, legislation and improper municipal solid waste dumping are the three problems that facing by the Brunei government. Because of this condition, the Brunei government really concern toward the municipal solid waste management. The government has already setted up a budget for municipal solid waste management and create integrated waste management system and amended the Minor Offences Act Order 2006.

The Brunei government should have a good coordination of policies among governmental agencies and private sectors, increase public awareness and education in the country, For example by introducing several course or subjects related to environmental protection and increase the involvement of the public and private sectors. A firm commitment by government working hand in hand with the private and public must be formulated in order to ensure environmental sustainability for the future generation. Finally, introducing other solution than lanfilling the waste is a must.

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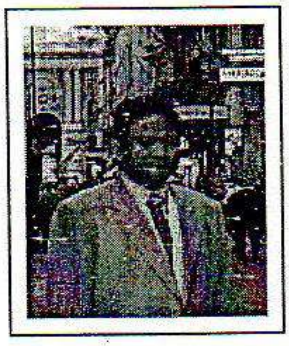
Profile



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