WASTE MINIMIZATION
AS SOLUTION OF MUNICIPAL SOLID WASTE PROBLEM IN INDONESIA

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ABSTRACT: The average generation of municipal solid waste in Indonesia, contains about 70% garbage, is about 2.5 – 3.0 liters per capita per day. Until the present, the authority of urban municipalities is transporting the solid waste from designated collection disposal to a final dumping site. At the national level, only 60% of the waste from the urban population is collected, the rest is burned and disposed off into streams or open land. Most of the local authorities practiced crude open dumping, creating a despondent situation at the landfill sites. The concept for solid waste management in municipalities being practiced so far, especially in the large cities, should now have to be improved. The potential for waste minimizing has not been fully realized. To be able to function satisfactorily, the concept should be integrated in a comprehensive waste management system. The waste should be managed and reduced, as much as possible, around the points of generation, by means of reuse and recycling. Only the non-utilizable residue will then be transported to the final disposal.

KEYWORDS: municipal solid waste (MSW), final disposal site (FDS), reduce, reuse, recycling, composting, waste pickers, informal sector

Introduction

The rapid population and diverse activities in large cities in Indonesia, such as Jakarta, Surabaya, Bandung, etc., have resulted in the emergence of common problems in urban infrastructure services, such as the problem of municipal solid waste (MSW). The estimation in 1995 was that only around 40% of the MSW in cities in Indonesia that could be transported to the Final Disposal Sites (FDS), where landfilling were mainly in operation. In formal reports, the proportion of transportable MSW was usually reported in greater numbers, just to pronounce the success of city administrators in managing their wastes. The waste managers rarely consider the amount of wastes that were handled by communities in a self-help manner, as well as the scattered or spilled out wastes that will systematically be disposed in water bodies.

As yet, the most reliable method used by city administrators in MSW handling is disposing them for open dumping or some of them by simple landfills at the FDS. The problem is that the city administrators tend to pay less attention to the respective FDS, and thus, the cases of FDS Bantar Gebang in Bekasi and FDS Keputih in Surabaya turn up, as well as of other FDSs not yet exposed in the mass media. The city administrators seem to consider that the FDSs they have could solve all problems of waste, without having to pay proportional attention to the facility.
MSW management in Indonesia

The average generation of MSW in Indonesia, contains about 70% garbage, is about 2.5 – 3.0 liters per capita per day. Until the present, the authority of urban municipalities is transporting the MSW from designated collection disposal to a location for its final dumping. Most of the local authorities practiced crude open dumping, creating a despondent situation at the landfill sites. The present level of recycling and composting (about 8%) will not be sufficient to slowdown significantly waste generation in the future. The potentials for reuse and recycling have not been fully realized because of a multitude of problems, such as the current solid waste management practices carried out by the City Cleansing Division (Dinas Kebersihan).

To get a picture of municipal solid waste generation in Indonesia, Table 1 presents figures of waste generation in several cities, quoted from various reports, as follows.

Table 1:
Waste Generation in Several Cities in Indonesia (2002)

<table>
<thead>
<tr>
<th>City</th>
<th>Population</th>
<th>Ton/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jakarta</td>
<td>9,527,800</td>
<td>6,195</td>
</tr>
<tr>
<td>Surabaya</td>
<td>2,837,000</td>
<td>1,702</td>
</tr>
<tr>
<td>Bandung</td>
<td>2,136,924</td>
<td>1,763</td>
</tr>
<tr>
<td>Makassar</td>
<td>1,300,000</td>
<td>780</td>
</tr>
</tbody>
</table>

In general, the task of the City Cleansing Division is to convey the waste from transfer stations to the final disposal site, whereas the urban community manages the waste collection from houses to the transfer station themselves. In certain protocol areas and special zones, door-to-door collection is applicable. Since the economic crisis, the income through retribution in the city was decreasing along with the slackening capacities of the people. It is indeed hard to raise the retribution, considering the still limited capacity of the people. The estimation in 1999 was that only around 60% of the MSW in large cities in Indonesia that could be transported to the final disposal sites, where landfilling was mainly in operation [Damanhuri and Padmi, 2000]. Nevertheless, there is a great possibility that the real amount of transported waste is less than the above figure.

The existence of a landfill turns out to be very important for waste handling in Indonesia. Without a disposal site, the accumulated wastes will create problems such as happening in Surabaya and Jakarta in 2001.

Landfills as Mainstay for Solid Waste Management in Indonesia

The main activity for waste disposal at the FDS is landfilling. It is common for the waste managers in Indonesia to consider a landfill located at a FDS to be capable of solving the problem of waste, and that the FDS could perform its task by itself without adequate operation and maintenance. As the FDS is the place where wastes from all parts of the city are concentrated, and sometimes also accept other kinds of wastes, indeed, this situation calls for more serious and greater attention from the waste managers. The handling and operation of a FDS should become a priority of the waste managers. Activities at the FDS comprise not only of piling up the wastes. There are many good examples in certain FDSs
in Indonesia, proving that a FDS could creatively develop a better environment, at least at the beginning of its operation [Damanhuri and Padmi, 2002].

Disposal and dumping of wastes or the other solid refuse into the ground is a common method, as other handling alternatives have not yet been able to solve the existing problems. This method has many risks, particularly the possibility of polluting the groundwater. Even the developed countries are still using the method, though in a gradually decreasing proportion. This is due to the fact that there is yet no appropriate method to replace it for disposing the remaining wastes. Dumping of wastes into the ground is known as landfilling, and up to the present, it is the most practiced method due to it being relatively low-cost, easily operated, and its flexibility in taking on the wastes. However, this facility may create problems to the environment, especially of leachate polluting the groundwater. It could also lead to the emanation of unpleasant odor and annoying flies, as usually the facility is not satisfactorily prepared and operated.

Landfilling was first applied to urban solid wastes, and, considering the aspect of environmental sanitation, this method is known as sanitary landfill. The main criteria being used ever since the introduction of sanitary landfill at the beginning of the year 1900s was namely to spread the solid wastes in layers in the dumping area, then compacted, and covered with a layer of soil by the end of the operation day. The criteria had been developed to suit the needs, however, for a country like Indonesia, it is still considered too costly. The main reason for this practice is that it is difficult to cover the dumping area with soil layers, let alone, compaction of wastes layer by layer. Problems of stench, flies, and smoke are effects of non-application of covering soil layers. The covering soil layer will also reduce the infiltration of rainwater into the waste heaps, thus, reducing the quantity of leachate.

In Indonesia, the present practiced concept for a FDS site is usually based on administrative borders. This is understandable, as the FDS manager is usually the Cleansing Office, working under the auspices of the Local Area Government (PEMDA). Differences regarding the administrative borders have sometimes brought unfavorable effects, such as the different perceptions between the respective local area governments. Such case had developed in Bantar Gebang (Jakarta and Bekasi), Leuwigajah (Bandung Municipality and Bandung Regency), and the likes. In relation with the local area government autonomy, such disputes will occur more frequently.

Usually, the area needed for a FDS site will only be considered when the existing one is full or when there are problems in the operation. There is yet no area with forward visions that incorporates the need for this sector in their spatial planning concept. Most commonly practiced is direct nomination as that particular site is the one available at that particular time. A good site will play a significant role in reducing the negative impacts of landfill operations.

Is it Really Necessary to Transport all the Wastes to the FDS?

Considering the waste composition that comprises most of food rests, kitchen garbage in particular, the urban solid waste will quickly rot, or degraded by the great number and diverse microorganisms in the natural environment. The process will greatly reduce the waste mass. This phenomenon is in fact being developed into composting or bio-
gasification techniques. However, when the mechanism takes place in a natural manner, particularly in environments where their carrying capacities have been exhausted, then there will be the problems of flies and stench, emanating from the improperly managed wastes. Considering the Indonesian condition, with a high relative humidity and relatively high temperature, the microorganisms will ‘devour’ the organic wastes at a faster rate as well. This is in fact not a new issue in the field, for example, composting could start from the houses, at the transfer station and finally the FDS.

**Waste as Useful Biomass**

Composting is one of the various techniques for treatment of waste containing biodegradable organic materials. Compost will not only function as organic fertilizer, it will also improve the soil structure, increasing the soil capacity to absorb and retain water as well as other nutrients. Compost is considered of good quality when it has the characteristics of humus and it is free from pathogenic bacteria. In this case, the composting of urban solid waste will have dual objectives, namely of elimination of the urban waste and at the same time, to produce materials to support agriculture.

Individual composting using composters had been introduced and field-tested by the Ministry of Public Works several years ago. Using containers with a volume of about 60 liter, kitchen garbage, especially food leftovers, could be processed and thus, a reduction of the waste volume due to degradation. Typically, such composter could hold the kitchen garbage of a household for a period of around 6 months before it is full. When the container is full, compost will then be produced, which need further processing.

One of the efforts in Jakarta to handle the accumulated waste for transportation to the FDS is through developing the concept of *Usaha Daur-ulang dan Produksi Kompos* (UDPK, Waste Recycling and Compost Production Business Enterprise), started around the year 1991. However, out of the 13 UDPK units that were developed, according to latest information, there is now only one unit that is still in operation. One of the weaknesses is that it seems that the urban solid waste managers had not considered the units, which were managed by the small investors, as part of the overall solid waste management system. These small-scale undertakings still need to be developed, and when necessary, subsidized in accordance with their contribution in the amount of waste that they could handle, which is namely a reduction of the amount of waste for transport and disposal at the FDS.

Solid waste is also a source of biomass as for animal feed or for worm culture. Especially for worm culture, the suitable kind of solid waste is plant material or vegetable waste, namely kitchen garbage. Vegetables, fruit and food leftovers, are highly suitable for worm feed. The species of worms commonly used for worm culture is *Lumbricus*. However, as worms are sensitive to environmental factors, namely pH, humidity, as well as other predators that might grow on the waste. This effort will produce vermi-compost, a casting product, and worm biomass, which is rich in protein for animal feed or for other uses.

**Energy from Waste**

In fact, the discarded waste holds a certain amount of energy that is utilizable. Utilization of waste energy is usually done by methods of:
- Catching the biogas as a product of an anaerobic degradation process, through: using specially made reactors (digesters) catching the produced biogas of a landfill
- Catching the heat produced as result of burning, for instance, through incineration.
- Using the waste as material for fuel pellets.
- Anaerobic pyrolysis and gasification will also produce certain fuels for use as energy source.

One m³ of biogas containing 50% methane could produce about 5500 kcal of energy, which is equivalent to 0.58 liter of gasoline, or equivalent to 5.80 kWh of electricity. In Valorga (France), namely a pilot project for methanization of municipal solid wastes of industrial scale, a digester of commercial scale could produce 140 L of biogas from 1 kg of dry waste containing 65% methane.

Literature studies provide a picture about biogas production at a landfill of 20-25 ml/kg dry waste/day. A proper landfill should already consider the facility for biogas capturing, at least by the end of the use of the landfill site. The produced biogas may lead to negative effects when improperly handled, it may cause explosions when it remains in the open air with a concentration of about 15%. Therefore, one may consider the production of methane gas an added value of a FDS, by utilizing the produced gas as a source of energy. Several industrial countries have commercialized the FDS produced gas by selling the gas to neighboring industries in the area. Theoretically, the potential of biogas production from the heaps of wastes in Indonesia is considerably high when compared to the industrial countries, which are mainly situated in colder areas. Nevertheless, the problem of the FDSs in Indonesia is that the landfills are in general operated in an open dumping manner, which may result in the gas being unfocused towards the collecting points.

**Waste Incineration**

One of the several waste-treatment technologies often used as an alternative for waste handling, is incinerator. For municipal solid waste in particular, an incinerator would be considered as appropriate when it does not need an extra subsidy for energy. Thus, the waste should have to be burnt using its own energy. Suitable waste for incineration should have at least a calor value of 1500 kcal/kg dry waste. As for the municipal waste in Indonesia, such figure is the highest. The Indonesian city waste is also known to have a high water content (about 60%), making it difficult for self-burning.

Such as the case with landfilling, the application of incinerators has always caused disputes due to differences of understanding, as well as apprehension for the impacts of improper management. Several industrial countries, such as Germany had limited the use of landfills for wastes with high organic content like municipal waste. Their landfill would only accept the ashes from incinerators. On the contrary, Japan has great anxieties regarding their incinerators, afraid that they may produce dioxin.

In Indonesia, modular incineration is also often mentioned as an alternative to reduce the amount of waste mass for transportation to the FDS. A number of Cleansing Department Offices have already seriously shown their interests for waste incineration at area level, namely before transportation to the FDS. The arising problem is on how to find the suitable locations, and most important is on how to mitigate the negative impacts of air pollution that may occur. In the industrial countries, the heat energy produced from incinerators had
already been benefited for various uses, such as for heating the city during winter, and electricity power generation. Indeed, such energy utilization would call for mature planning and preparedness, such as the market that will buy the product, and the likes. This is because the investment cost will be higher than investment for ordinary incinerators. Having a calor value of 1000 kcal/kg, indeed it could reach an overall efficiency to produce electricity of less than 5%, namely about 6000 kW for 1000 ton of waste. The kind of waste considered as suitable for conversion into electricity is usually the ones that have an overall efficiency of at least 10%.

Waste Recycling in Indonesia

Considering waste composition, most of the municipal solid wastes in Indonesia comprise of degradable waste, or commonly known as organic waste. In large cities, such organic waste could reach 70% of the total waste. Around 28% of the municipal solid waste are non-organic waste, which is a quite potential resource for the waste-pickers, starting from the source of waste (houses), until finally dumped at the FDS. The remaining 2% of the waste are materials considered as hazardous waste, which need special treatment. Based on these facts, around the year 1980 the Center for Research on the Environment of Institut Teknologi Bandung (PPLH-ITB) had introduced the concept of Kawasan Industri Sampah (KIS, Garbage Industrial Estate) at an area level. The idea is to minimize, as much as possible, the amount of waste for transportation to the FDS with the involvement of community self-help in waste recycling activities. The concept had been tested in several cities, including Jakarta. However, as usual, the concept was not smoothly applicable as it calls for the readiness of all parties to change their way of thinking and perceptions regarding waste handling.

Technically, the success of such methods depends greatly on how to separate the waste as early as possible, namely to start from the houses or other points of waste generation by using separate waste bins. This undertaking will then be followed by the provision of waste carrying carts, which are designed to comprise of several compartments to hold the different, already separated wastes, and special trucks for transporting separate kinds of waste for further processing. Lacking such efforts, it seems that the waste recycling activities would not be successful. Further on, when someone or a group of people has been able to reduce the amount of transportable waste systematically, they are entitled to receive a bonus for their activities, at least a reduction to the retribution they have to pay as a usual routine so far. Such practice seems to be difficult to realize, as the targets of retribution had been determined not based on the waste for the waste managers to handle but based on the number of population in the area.

Efforts for promoting the recycling or reuse of waste that are still utilizable by the waste pickers should also be incorporated in the attempts to reduce the amount of waste for dumping at the FDS. Such efforts are most noticeable ever since the source of waste until it is finally dumped at the FDS. Food leftovers proved to have the potentials for recycling, for example, to sell them as animal-feed, such as the case in FDS Suwung Bali and the nearby pig farms. Nevertheless, the problem of such uncontrolled waste picking at the FDS had become one of the issues at FDS Bantar Gebang. Theoretically, the amount of waste capable for recycling by this method, including the wastes at the FDS, will not exceed 10%. However, monitoring the situation in Jakarta and Bandung revealed that the figure had not even reached 2% of the available wastes.
At several FDSs in Indonesia, it is common to see certain recycling activities before the wastes are buried at the landfill. Most commonly found is the production of compost, such as at FDS Grenjeng (Cirebon), FDS Leuwigajah (Bandung), FDS Rawa Kucing (Kota Tangerang), etc. Certain FDSs have also been equipped with units of modular incinerators, such as FDS Sukamiskin (Bandung), FDS in Makassar, FDS Medan, etc. At some places, the ashes produced from incinerators are utilized as blending material for batako (concrete brick) due to the considerably high silicate content.

**Optimization of FDS Sites**

The problem that is always of great concern for the waste managers of municipalities is on what to do when the FDS is full. Available sites for FDS in a growing city will be harder to find, the location will be farther away from the city, and the land price tend to increase, in competition with the other users. Another problem is that suitable land areas for a FDS are not always available in the respective municipality, and people become more open to expressing their reluctance to have a FDS in the neighborhood, due to the unfavorable image the FDS has so far.

Therefore, besides the efforts to reduce the amount of waste, it is also important the endeavor to prolong the FDS’s service period or service life, as long as possible, using various methods, for example:

- Applying systematic landfilling operation management at the FDS.
- Combining the burying of waste with the other waste handling methods, such as composting, production of animal feed, worm culture, or incineration.
- Promoting waste recycling at the FDS while exerting efforts for safe operations.
- Renovating the old FDS through utilization of the old waste heaps as compost or daily sand covering layers or for construction of embankments for burying the waste.

One of the efforts to prolong the service time of a FDS is through systematic landfill operation. A satisfactory landfill operation is indeed the system that should always be planned for operation at any time. A simple example is the practice of FDS managers to bury the waste by simply pouring the waste as heaps. They are reluctant to apply the classic system of sanitary landfills, namely to evenly distribute the waste layer by layer and have them compacted. This is a simple operation, however, it calls for a little more effort and additional costs, but its long-term advantage is quite significant to prolong the service life of the FDS.

Accelerating the deterioration of waste at landfills is one effort to improve the system being practiced so far, for example, the chopping of waste before burying, supplying air into the waste heaps, and re-circulation of leachate. Such practice is called accelerated landfill. The already full FDS does not have to be directly left behind, giving up the available infrastructure and facilities. The heaps of putrefied waste of more than 5 years are anaerobic compost products that could be utilized, and thus, extending the life of the FDS. The commonly practiced procedure is the digging up old areas, converting the old heaps of waste into compost. Residual waste materials not suitable for composting could be utilized as sand covering layer. The produced compost will be as good as normal compost. However, the product will need some grinding and sieving to produce good quality compost. The remaining residue is not suitable for final sand covering layer,
nevertheless, it could be used for daily covering layer or blending material for the construction of embankments for landfill operations. Thus, the existing sites for landfills could be repeatedly used, and even better when operated by turns.

It will be increasingly difficult for the large cities in Indonesia to obtain land areas for FDS. There is also the possibility that even the existing sites will technically become unsuitable for use as a FDS due to the increasingly denser population and housing, and the likes. The longer the service period of a FDS, the cheaper is the costs. Therefore, a centralized and integrated FDS will greatly reduce the problems that might arise. The FDS will serve the waste from the surrounding areas without having to consider from which Pemda the waste is coming. The decisive parameter will only be the amount of incoming waste.

Closing Remarks

The concept for solid waste management in municipalities being practiced so far, especially in the large cities, should now have to be improved. To be able to function satisfactorily, the concept should be integrated in a comprehensive waste management system. The waste should be managed and reduced, as much as possible, around the points of generation, by means of composting or using other recycling techniques. Only the non-utilizable residue will then be transported to the FDS. Other efforts should also be promoted at the FDS, to minimize the amount of waste for burying. The FDS should not be only a place for final disposal, but a final processing site. Another fact is that waste handling is normally not an important priority out of the many problems the city administrators have to deal with. The task of waste managers will not become easier in the future. If the existing capacities and undertakings remain the same as it is at present, surely their capabilities to handle this sector will be decreasing along with the aging of the available infrastructure as well as inadequate investments.

Environmental cleanliness is an important factor to achieve environmental hygiene and it is a distinct problem in environmental sanitation programs. Dirty environments, for example as a result of poor waste management, could induce diseases to communities. Besides esthetic factors, the waste piles could also turn into a place for growth of disease vectors (flies, rats, insects) that might infect people in the surrounding areas. The increasingly greater amount of waste transportable to the FDS is not a guarantee that the city will become cleaner. Quality cleanliness of a city depends more on the participation of its community in maintaining cleanliness. At present, promoting community participation for enhancing cleanliness in Indonesia will depend more on efforts of approaching the communities, both formally and informally.

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