

## Municipal Solid Waste Management in Vietnam: Status and the Strategic Actions

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**ABSTRACT:** In Vietnam, municipal solid waste (MSW) has been become increasing complex due to variety of reasons as the increasing quantity, changing composition of MSW, rising public awareness and municipal administration policies among different cities and surrounding communities. There is not currently an efficient management system in place for facilities such as storage, collection, transfer, transportation and disposal of MSW. Against this backdrop, this paper attempts to analyze the present system of MSW addressing variety of aspects such as quantity and composition of MSW generation, operational management, legal system as well as financial aspect. The systematic assessment has revealed the problems like lack of legal framework, low coverage, improper waste storage, less encouragement for composting, and lack of proper disposal practices. Finally, an action plan is proposed suggestion for current and future addressing the issues as the operational management, institutional, financial aspect, public participation, environmental education, and legal and policies.

**Key words:** Solid waste management, Waste collection, Disposal, Strategic actions, Vietnam

### INTRODUCTION

Increasing waste generation due to rising population and waste generation rate become a challenge for Vietnam government to establish proper MSW management. Recently, MSW management in Vietnam takes a serious attention at different levels of governments as well as at community level. Weak waste management is a common growing problem facing developing countries. There is a need for specific action at the international level to establish, inspire and encourage new forms of cooperation, partnership, coordination at all levels, in order to contribute effectively to the provision and improvement of waste management services.

Recently, Vietnam has faced great challenges in solid waste management including not only the collection, transfer, and final disposal of waste, but also a lack of public awareness of the solid waste system, haphazard urbanization, the introduction of environmentally unfriendly materials, and changing consumer consumption patterns.

Vietnam with the total area of 331,210 sq km is one of most populous country in Southeast Asia. In July

2009, its population was estimated to be approximately 86,967,524; and its population growth rate was 0.977%. In contrast to that, approximately 28% of the country's residents currently live in the cities; its urbanization rate was 3.1% annual rate of change (CIA Factbook, 2009). Solid waste is a growing problem for Vietnam. The country is producing more than 15 million tons of waste each year, and this volume is expected to grow rapidly over the next decade. Urban areas produce more than 50% of the country's municipal waste. In addition, expanding urbanization, combined with industrial growth and the modernization of healthcare services, will lead to a significant increase in hazardous and hazardous healthcare waste generation, posing serious health concerns if not properly managed. This paper presents the situation analysis of prevailing MSW management in Vietnam addressing mainly the operational, financial and legal aspects for storage, collection, transportation, treatment and disposal systems. Accordingly, the shortcomings have been identified and a strategic action plan for short and long term is suggested.

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### Institutional arrangement for Waste management

Vietnam faces institutional challenges to the effective waste management from the national to the provincial levels, which the management of waste varies from one place to another. The Environment Protection Law was introduced in 1994 but standards and regulations for urban management and waste management have just enacted and not completed yet. The government has full authority for environmental protection throughout the country. The Ministry of Natural Resources and Environment (MoNRE) is authorized by the government to implement state management of environmental protection and nationwide coordination of all environmental protection activities in Vietnam.

There are several Ministries directly involved in waste management. The main Ministry responsible for solid waste management (SWM) in Vietnam is the MoNRE - for environment management, monitoring and assessment. Additionally, five other Ministries are also directly involved in waste management activities. These Ministries have specific role to play in SWM system, the institution arrangement at national level of Ministries for managing the solid waste management in Vietnam presented in Fig. 1. The provincial and municipal governments play key roles in providing services of SWM, consisting Peoples' Committee (PC), Department of Natural Resource and Environment (DoNRE), and Urban Environment Company (URENCO).

PC is responsible for state administration at the local level. Its responsibilities in waste management are such as i) implementation of state management regulations on environmental protection in their respective localities, direct their functional agencies in organizing, coordinating with the functional agencies of the central level; ii) direction and consultancy for proper waste management facilities, waste treatment projects in terms of design, construction, monitoring, etc; iii) and investment and subsidization for solid waste management and treatment facilities.

DoNRE is an agency of MoNRE, it also operates under the influences of both parties: PC in terms of

administrative and political relations and MoNRE in terms of collaboration, support, and technical guidance. DoNRE plays an important role in waste management with respect to monitoring environmental quality, managing and implementing waste management policies and regulations issued by MoNRE and PC.

URENCO, an agency of DoNRE or PC, is the main company in charge of waste collection, transport, and treatment in the province or city. Besides URENCO is also in charge of solid waste collecting, keeping hygiene for public place, public lighting, planting and taking care of trees along the street.

### MSW management system

MSW management in a city is managed by URENCO which has responsibility to collect, transport and treat the solid waste generated from residential areas, streets, commercial areas, offices, markets, industrial parks, hospitals, etc. Besides, private companies, recycling companies also participate in some cities for MSW management activities.

MSW generation from various sources in municipal area is temporarily stored at convenient locations. Next, this is collected, transferred and transported to intermediate treatment facilities and final disposal site. The overall system consists of waste storage, collection system, transfer station, transportation and final disposal presented as Fig. 2. and each stage of the management system is described below.

### Quantity and composition of municipal solid waste

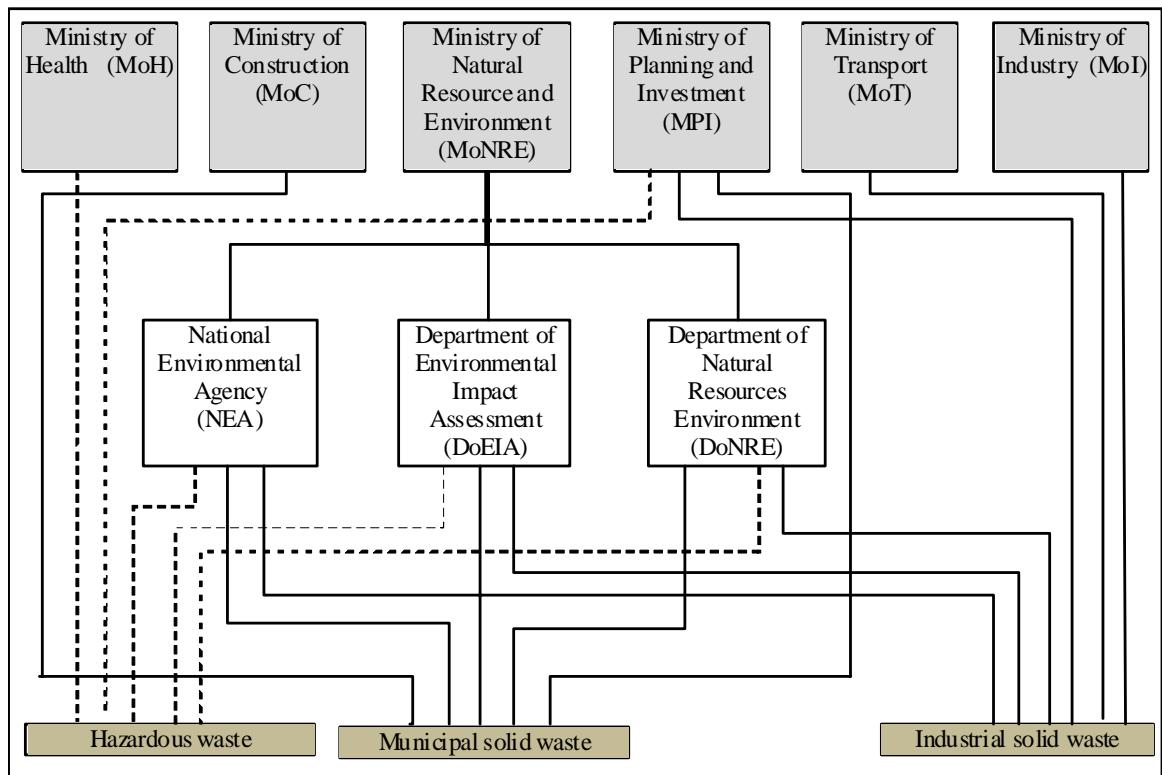
The general waste generation in Vietnam by the year 2003 presented in Table 1, the waste generation amounts to over 15 million tons each year; in which MSW accounted for very large proportion, about 80%, while industrial waste accounted approximately 17%, and hazardous healthcare waste from hospitals accounted about 0.14% (see Fig. 3). As one significant aspect of MSW in Vietnam's cities, it is large volume and amount of waste generation, high percentage of organic matters in total waste generation and various compositions.

Cities in Vietnam are major generators of MSW. Urban areas contain only 24% of the country's

**Table 1. Waste generation in Vietnam in 2003**

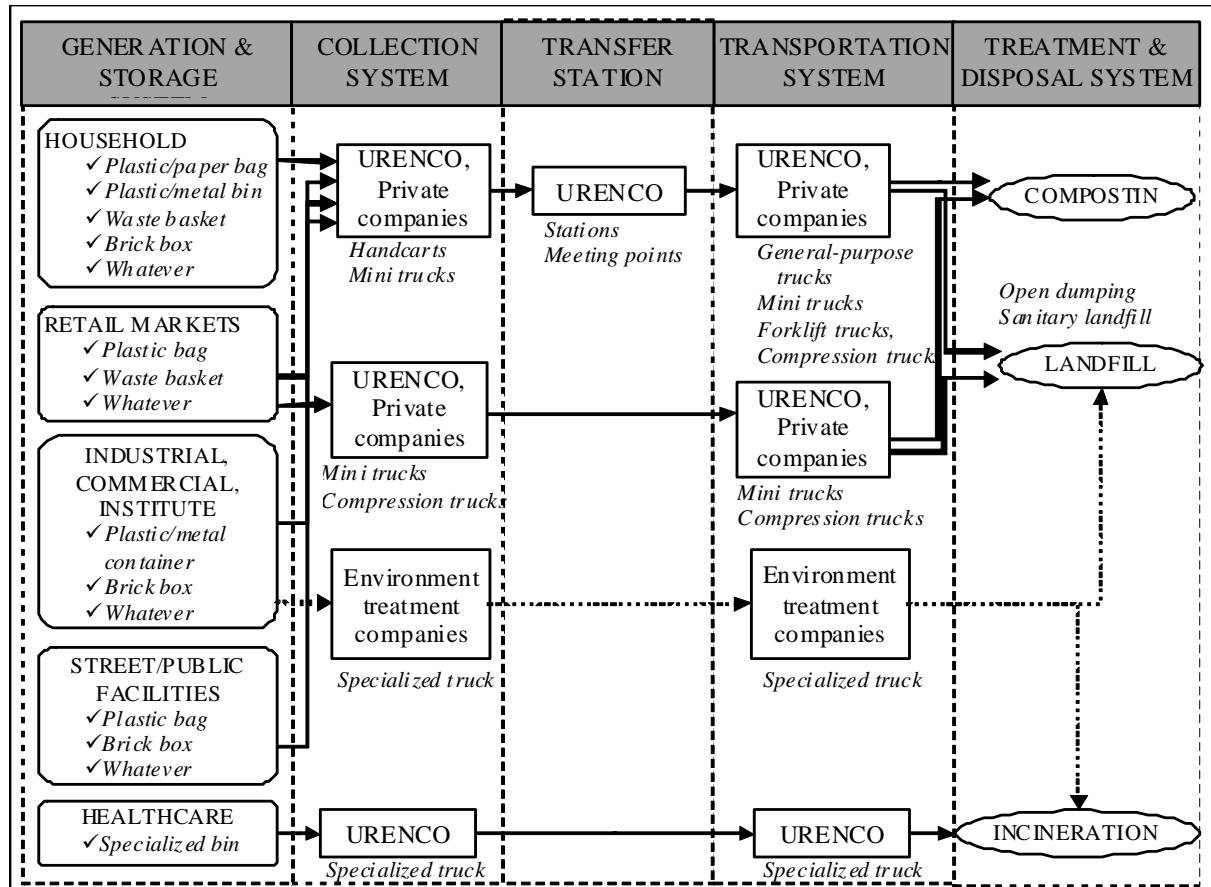
Sources	Waste generation (ton/year)		
	Urban	Rural	Total
Municipal waste	6,400,000 (50%)	6,400,000 (50%)	12,800,000
Industrial Non-hazardous waste	1,740,000 (69%)	770,000 (31%)	2,510,000
Industrial hazardous waste	126,000 (98.4%)	2,400 (1.6%)	128,000
Hazardous healthcare waste	-	-	21,500
Total ( <i>excluded agriculture waste</i> )	8,226,000 (53.3%)	7,172,400	15,459,900

(World Bank, 2004)

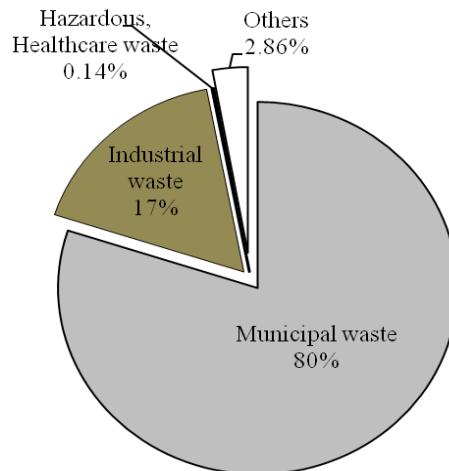


(Viet et al., 2009)

**Fig. 1. Institution arrangement at national level of solid waste management in Vietnam**



**Fig. 2. Schematic diagram of waste management system in Vietnam**



(World Bank, 2004)

**Fig. 3. Waste quantity distributions in Vietnam**

**Table 2. Municipal solid waste generation and collection in major cities/areas in Vietnam**

City/area	Population (2003)	Generation rate (kg/cap/day)	Waste generation amount (% of total)	Organic content (%) (%)	Collection rate (%)
Ho Chi Minh City	5,554,800	1.3	9	80	73
Ha Noi City	3,007,000	1.0	6	59	81
Da Nang City	747,100	0.9	2	77	80
Can Tho City <sup>(*)</sup>	1,114,300	0.45	2	77	80
Urban area	20,869,500	0.7	50	55	74
Rural area (National)	60,032,900	0.3	50	60-65	-

(World Bank, 2004)

(\*) Can Tho's DOST and City people's committee, 2004

population but produce over 6 million tons of waste each year, 50% of the country's MSW (see Table 1). Table 2 presents the waste generation in the major cities in Vietnam by the year 2003. It is estimated that an average urban resident in Vietnam produces over 0.7 kg/cap/day, about twice the amount produced by people in rural areas. In a study carried out by the World Bank (World Bank, 1999), shown the interaction of the percentage of urban population and the GNP per capita to the waste generation rate (kg/cap/day) of Asian countries, presented in Table 3. In which, the generation rate of Vietnam is a little lower than other countries. MSW contains a large proportion (60-80%) of easily biodegradable organic waste. Table 4 presents the typical physical composition of MSW in Vietnam at source, transfer station and landfill site, respectively.

#### **Storage at generation points and collection system**

In Vietnam, MSW are mainly collected at urban central areas and apart of sub-urban areas. Solid

wastes in rural areas are collected and treated by generators with many disposal alternatives, which have not been intervened by municipality. Up to now, there are rare documents or guidelines relating to rural solid waste management. The collection rate mentioned in this paper is only the rate at urban areas.

#### **Residential area (households)**

At residential areas, the waste storage is not similar on size, volume, shape, color, etc. Generally, waste storage is forms as plastic/metal bin, the fixed brick-box or temporary bin, putted in front of the house. Many cases, that the storage is temporary containers as plastic bag, paper bag or throw away on the sidewalk of the street. Most of the waste storage is open system with varying capacity from 5 to 100 liters.

In the urban districts, citizens place their waste out on the open gutters of the street in front of their dwelling for URENCO employees to pick up. The trash is transported by handcarts, which have various types

**Table 3. Municipal solid waste generation in different Asian countries**

Country	GNP per capita (1995) (US \$)	Urban population (% of total)	Urban MSW generation (kg/capita/day)
Nepal	200	13.7	0.50
Bangladesh	240	18.3	0.59
Myanmar	240	26.2	0.45
Vietnam	240	20.8	0.55
Mongolia	310	60.9	0.60
India	340	26.8	0.46
Lao PDR	350	21.7	0.69
China	620	30.3	0.79
Sri Lanka	700	22.4	0.89
Indonesia	980	35.4	0.76
Philippines	1,050	54.2	0.54
Thailand	2,740	20.0	1.10
Malaysia	3,890	53.7	0.81
Korea	9,700	81.3	1.59
Singapore	26,730	100	1.10
Japan	39,640	77.6	1.47

(World Bank, 1999)

**Table 4. Municipal solid waste composition in Ho Chi Minh City, Vietnam**

Components	Source	Transfer station	Landfill site
Food waste	65-95	78-83	60-90
Paper	0.5-2.5	2-6	1-4
Textile	0-18	0.5-6	6-12
Plastic	2-19	6-25	10-30
Leather	0-3	0-1	0-0.2
Wood	0-1	0-2	0
Metal	0-2.9	0-0.1	0
Glass	0-3	0-0.1	0
Rubber	0-0.5	0	0-0.2
Ceramic	0-1.2	0-0.2	0-0.4
Construction	0-5	0-4	0-1.5

(MOC, 2003)

with a capacity of 0.6-1.5m<sup>3</sup> (see Fig. 3). The collection activities carried out daily by the URENCO collectors pushing handcarts on foot door-to-door. When the handcarts are full, they are transported to a designated transfer station not far away where a waste truck will transport the waste to the nearest dumpsite or landfill. In places where there are no transfer points, residents are provided with a communal container and are responsible for disposing their waste into the containers. A URENCO truck daily comes to unload the communal container and transport it to the dumpsite.

#### ***Commercial, industrial and institutional areas***

For large commercial and industrial areas, these generated 3 kinds of solid waste as domestic waste, hazardous waste and recycling waste. Domestic waste

is collected by waste trucks of URENCO via engagement contracts between generators and URENCO. Regarding hazardous waste, generators are responsible to rent the solid waste treatment companies or private agencies which are certificated the permission by city environmental authorities (DoNRE), based on basic contract for waste collection, transportation and treatment.

Healthcare waste is managed and collected by local URENCO as well. The storage is refuse bin, which operated like close circulation between hospitals and incinerators by specialized trucks (see Fig. 4). The refuse bin's volume is about 120L; it has covered and recognized by specially symbol outside of the refuse bin.



**Fig. 3. Various handcarts for door-to-door collected waste**



**Fig. 4. Healthcare waste collection and transportation**

#### *The street*

Each household is responsible for the removal of waste in front of his/her house. Wastes from main roads are swept by the municipal employees. For commercial areas, street sweepers are responsible for keeping public streets and facilities clean, including city yards, terminals, etc. Street sweeping is carried out both manually (with brooms) and mechanically. Mechanical sweeping vehicles usually clean only the main streets in large urban centers. Although street waste constitutes a very small fraction of the overall waste stream, a significant portion of the work force for the waste management is allocated for the street cleanliness.

#### *Retail market area*

There are two types of retail markets: permanent and temporary. Since most of the permanent markets are adjacent to the roads and accessible by the handcarts; regarding to permanent markets the municipality may provide a truck to transport the wastes directly to final disposal site. For the temporary market, municipality provides handcarts to collect wastes from each shop and transport to transfer stations.

#### *Transfer station*

Transfer station is introduced for the purpose of convenience and to reduce the hauling distances for collection trucks, thus lowering transportation costs. Some of the transfer stations are relatively modern; provided with attendants and equipped with mechanical transfers and waste compaction, whereas others are simply a large steel container, concrete bin, and/or open space. Generally, the transfer station is overloaded and it is difficult to maintain the cleanliness. However, the most popular is meeting points (rendez-vous points), that is places on the street where handcarts come and wait the coming truck for transferring waste from the handcarts to waste truck. At the meeting points on the street that shown in Fig. 5. there are many problems as environmental pollution (leadchate from waste, bad smell, small sold waste spill, fly, etc), held up traffic, aesthetic city, etc.

Healthcare waste, industrial waste and construction waste that applying direct collection and transportation system, so there are no transfer stations or meeting points.



**Fig. 5. Transfer station (meeting point)**

### **Transportation**

Municipality is responsible for the haulage of wastes to the final disposal facilities. The transportation vehicles are waste trucks with loading capacity ranging from 4 tons to 13 tons. This included forklift trucks, compression garbage trucks or general-purposes trucks. Besides, waste vessels and boats are used for collection of waste in the canals and rivers (see Fig. 6). Due to the scarcity of land, most of the cities, the disposal sites are usually located outside of the city. There is no fixed route map for transportation. In big cities, since the traffic is very heavy, travel time to the disposal site is too long. Thus, daily average number of roundtrips made by vehicle is only two or three.

### **Treatment and disposal system**

#### *Composting*

Composting is the decomposition of organic wastes under controlled conditions to produce soil conditioner, compost, or organic fertilizers. Composting is potentially a very useful form of recycling of organic waste, and could help to increase the recovery rate of recyclable materials. This could contribute to a more efficient MSW system, but it is not yet widespread for a number of reasons, including inadequate attention to the biological process requirements; poor feed stock and poor quality of the fertilizers; and poor marketing experiences. Besides, old landfills have been utilized as sources of composting product, organic waste naturally decomposed in landfills.

Recently, many private companies initiate the composting in the cities. The composting technology is a little difference. The typical technology for organic solid waste composting as vermin-composting, presented in Fig. 7. The good quality fertilizer supplied the suitable nutrient components, it can sell to market in high price of 30 USD/ton. These companies contract to the municipalities for treating compostable waste, and they can earn money as treatment fee based on amount of waste treated from municipalities (10 - 15 USD/ton waste).



(a) Truck for waste Transportation

#### **Burning and incineration**

Incinerators are not commonly used by the municipalities in Vietnam; it is only applied in a few hospitals at the city level. Therefore, the healthcare waste is primarily disposed to landfills. Although, the implementation of incinerators is assessed by the government concerning for technical standards and gas emissions, Vietnam does not have the technology to analyze dioxin concentrations emitted by the incinerators (Dan and Viet, 2009). The existing incinerators are small capacity of 5 - 20 (tons/day) faced problems as they can not meet the standards about temperature and emission gases during the combustion process. The major reasons are as the low calorific value of the healthcare waste caused start-up problems, and fuel had to be added constantly to maintain the combustion process.

Open burning at landfill sites are commonly practice in few cities, especially in dry season to reduce the volume of waste at sites as well as to increase the capacity of landfill sites. Besides, burning of waste at households is practiced in urban and rural areas to rid the household waste. These burnings emitted toxic pollutants caused serious environmental damage and may endanger human health. Besides, accidental fires are often started at dumpsites caused spontaneously igniting methane gas produced during the decomposition of organic matter.

#### **Landfilling**

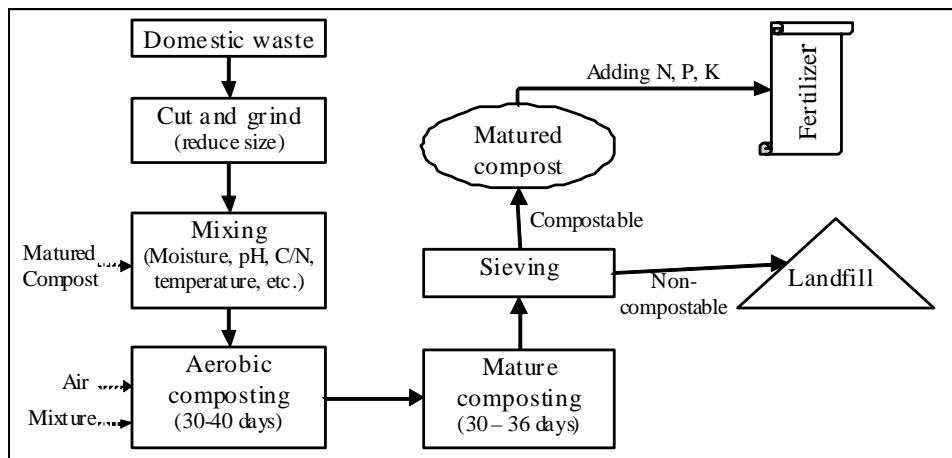
The waste treatment and disposal alternatives in Vietnam are implicit environmental and human risks by the poorly operated landfills and open dumps.

Generally, a municipality in Vietnam may have more than one disposal sites (Table 5). As other countries in Southeast and South Asia, open and controlled dumps are the dominant form of waste disposal in Vietnam (Idris *et al.*, 2004). Only 19.67% of cities/provincial capitals and 18.68% of total existing landfills in whole country have engineered or sanitary landfills



(b) Boat for collecting waste on canals and rivers

**Fig. 6. Main transportation vehicles of municipal solid waste in Vietnam**



**Fig. 7. The typical composting technology in Vietnam**

(World Bank, 2004). The existing unsanitary landfills have been caused serious problems as odour, air pollution, contamination of surface/ground water and soil, and other negative environmental impacts. Up to date, landfill leachate quality standards have not been available in Vietnam. The leachate from the existing municipal landfills has very high concentration of organic and nitrogen, although heavy metals content is low and acceptable (Dan and Viet, 2009).

Self-disposal is common in areas with no collection and disposal services. Households who do not have access to collection and disposal services, they use their own means of waste disposal. This often results in waste being dumped in nearby rivers or lakes, or discarded at sites near homes.

**Table 5. Disposal systems in Vietnamese cities**

Numbers of cities	Numbers of land fill sites each city
6	0
42	1
4	2
1	3
3	4
2	5
1	8
2	10

(World Bank, 2004)

#### **Informal recycling system**

Recycling is done mainly by the informal private sector (e.g. waste pickers, collectors, garbage truck helpers, scavengers, etc), and occurs at many points: the generation points, waste storages, collection, transfer points and at dumpsites (see Fig. 8). Waste reuse and recycling are already common practice in many households, and they are also being separated by junk-buyer, waste pickers, collectors or scavengers. They collect various materials including cardboard, plastics, glass bottles, scrap paper, scrap metals, etc.

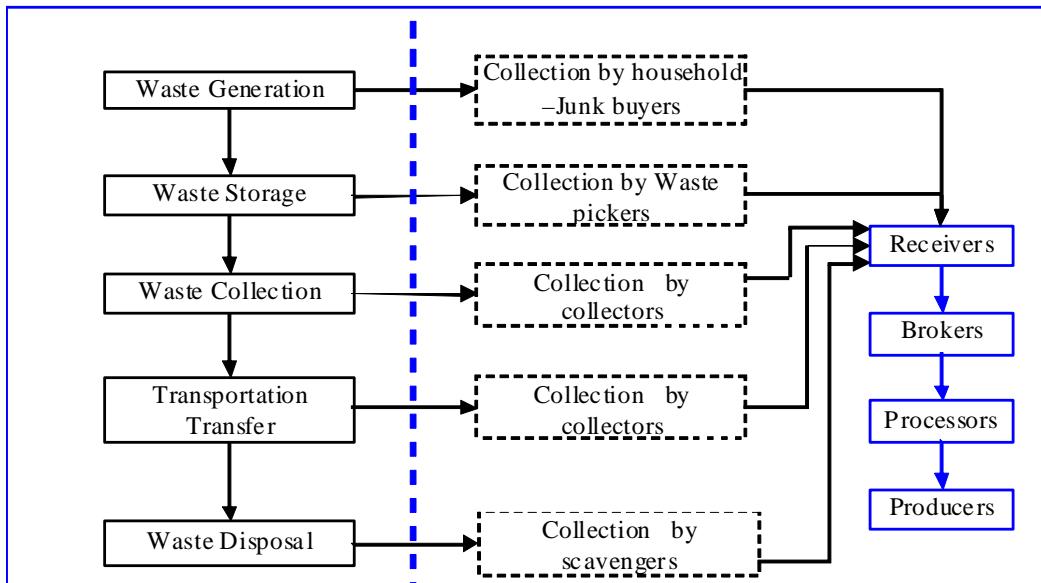
The recyclables are sold to the distributors; next, they will be cleaned, sorted, packaged the recyclable material, and preliminary process before reselling. However, recycling items reduces the quantity of wastes significantly for transportation to final destination (Pham, 2009). These waste recycling factories and enterprises contribute significantly to reduce the waste load. However, the technology for production is very low technology, low investment cost, etc. Most of these factories and enterprises cause environmental damage and product low quality production. Rates of recovery and recycling in Vietnam are high; recyclable and reusable waste accounted approximately 20% of MSW, which is higher than many Asian cities (World Bank, 2004). However, no information is available on quantity and quality of recyclable waste at the national level, city level and local level.

#### **Legal system**

Vietnam has put in place a sound legal framework for environmental protection that specifically addresses guidelines for the management and disposal of all waste streams. This framework is supported by two strategies that apply to solid waste management: (i) the Strategy for the Management of Solid Waste in Vietnam Cities and Industrial Parks (1999), and (ii) the National Strategy for Environmental Protection (2003). Moreover, the legal system supported by other relevant laws and policy documents such as decree, circular, joint circulation and standards.

#### **Financial aspect**

MSW collection system is paid by community citizens, the fee for MSW collection is as other community fees. This fee varies from 5,000 VND – 15,000VND (about US\$ 0.3 - US\$ 0.9) monthly per household. The amount of collection fee depends on the living condition of the residential area, it is decided by among community members. Besides, the municipality have to pay transportation and disposal



**Fig. 8. Recycling waste flow**

cost, this fee may vary from city to city. Every local enterprise (as URENCO) has to submit their annual budget for transportation and disposal of MSW. Subsequently, at the end of year, they have to submit their actual expenditure and return the excess amount to the municipality.

The financial budget for waste treatment and management facilities subsidized by government; fortunately, Vietnam also received the subsidization from international donors as ODA projects on SWM. The financial distribution for expenditure and investment on SWM are presented in Fig. 9 and Fig. 10. The financial for SWM have been become the burden for municipalities, although ODA projects supported a high percentage of total investment for SWM.

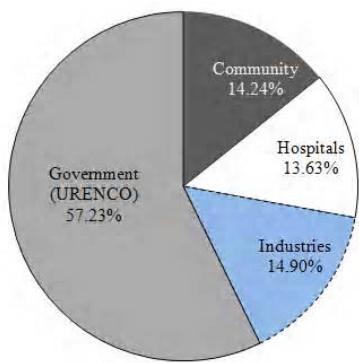
Main cities as Ho Chi Minh City (HCMC); by 2005, the annual cost for operation and management of SWM system are equivalent to 0.35% of GDP of HCMC. The city council has to spent a huge amount of money for building new domestic waste sanitary landfills, equipping/maintenance of machines and vehicles. The construction cost for 1 ha of sanitary landfill is about 160,000–200,000 USD, and operation and maintenance cost for collection and disposal of 1 ton of solid waste is estimated to be 5.0–6.5 USD. Solid waste management cost has increased with the increase in solid waste quantity. It is about 12–13% per year and becomes a burden for the city (Dan and Viet, 2009).

**Assessment of prevailing situation and problem identification:** MSW management in Vietnam is becoming more complex due to variety of reasons. The quantity of solid waste is increased by rising population and increasing waste generation rate.

However the local governments are not adequately equipped to provide the proper service due to lack of the managerial capacity and resources required to shoulder the increasing responsibility. Thus, the governments in Vietnam face a big challenge to deal with MSW management. The stage wise problems could be identified in the following manners.

**Lack of national policy and legal framework for MSW management:** The first step to improve the current situation is to work out a phased technical and legal framework for waste management. In which, each waste policy or legal framework is required that enables setting of objectives and targets. A well-elaborated legal framework can assist in effective implementation. The legal framework should also include an effective enforcement system.

**Lack coverage service for the waste collection, transfer and transportation:** In general, the coverage collection service provided by Vietnam municipalities via URENCO is insufficiently carried out, especially in low income and/or slum areas where the road is too narrow or in the isolated sub-urban area. Furthermore, solid waste in rural areas are not collected and treated by municipalities. Regarding transportation, it has been observed that general-purpose trucks are less efficient when compared with the specialized vehicles as far as the time required for loading and unloading, and the quantity of solid waste being transported. Moreover, waste transportation by trucks at rush hours is low efficient. The existing transfer stations are lack quantity/capacity, old technology, unsuitable location, and environmental pollution. Besides, waste collection, transportation and transfer facilities lack the participation of private sectors.



(World Bank, 2004)

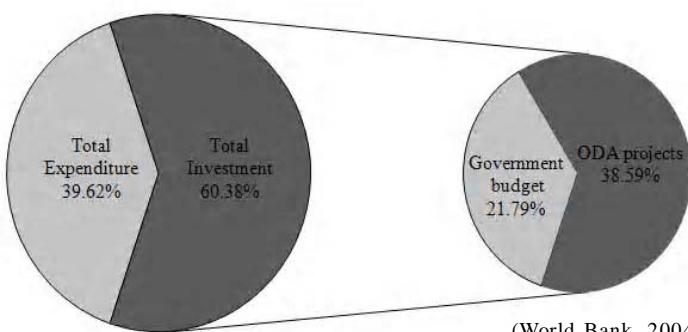
**Fig. 9. Financial budget sharing on waste management**

**The use of improper waste storage at the generation points:** Most of waste storage at generation points is open bins and temporary containers; in which wastes are easily carried by fly, rats and other rodents. Improper waste storage can because the drainage clogged up and lead to the flood. Both problems will propagate more if the waste is not picked up regularly.

**Less encouragement for the composting at community level:** Recently, many private companies initiate the composting in the communities. However, they are not supported the substance and policy by the municipality. The companies only receive treatment fee via contracts between them and municipality, however this fee cannot pay off for treatment process. Besides, sometimes they have insufficient market to sell the compost product. The existing composting plants may not operate properly for various reasons (e.g. technical issues, lack of market, comparably low quality of compost product).

**Lack of appropriate final disposal practices:** Poor operation of the final disposal site mainly operated as open dumping, which is resulted in the leakage of leachate to the surrounding areas, affected serious to surface and ground water. Self burning of waste contributes significantly to air pollution. Moreover, Vietnam currently does not have hazardous waste (healthcare waste and industrial waste) treatment facilities that can meet safety and environmental standards (Thai, 2009). Waste picking at final disposal may not only disturb the waste pickers' health but also reduce the efficiency of site operation such as waste unloading and spreading, soil covering, and compaction offsite.

**Strategic actions:** MSW management should be improved by adopting multi-pronged strategy. It would be necessary to clean the generation areas, widen collection system, adopt cost effective transportation, recover the resources from the waste and treat the finally proper disposals of the waste in the environmentally compatible manners. Knowledge on MSW management is significant for citizens in the communities, it would be necessary to make them aware



(World Bank, 2004)

**Fig. 10. Expenditure and Investment on Waste management**

for their responsibility and seek their participation in keeping environmental cleanliness. Accordingly, six major areas for strategic actions have been identified and discussed below.

**Collection and transportation:** The efficiency of MSW collection and transportation should be improved through increasing coverage of collection area, cost effective transportation by the use of vehicles and scheduled transportation system. The increased coverage may reduce the waste quantity disposed through improper way such as dumping into rivers, banks, ditches, etc; thereby protecting the environmental quality.

**Intermediate treatment:** It is considered that composting is appropriate for MSW generated in Vietnam which is dominated by organic wastes. The technical assistance and financial support should be provided by national and local government to improve the existing composting plants and to encourage composting at household level. The composting at source may help municipality to deal with the limitation of budget for transportation and disposal.

**Final disposal:** Land use plan should make a provision for landfill facilities as per the various sources of MSW generation. Municipalities with scarcity of land could share the site with their neighbor cities with clear understanding on sharing the responsibility. For SWM projects, the public should be involved in the project at beginning to promote their acceptance. The government should prohibit the development of new open dumping and improve the existing landfill site.

**Institutional and financial aspects:** Financially, the system could be more stable through public-private partnership. For this, it would be necessary to develop appropriate institutional arrangement so that there would be assured commercial viability for private sector as well as fulfilling the social responsibility by the public sector. With careful consideration of income level and regional variety, existing MSW management fee can be redesigned for better service.

**Table 6. Strategic actions of municipal solid waste management in Vietnam**

Aspects	Short term	Long term
Collection and transportation	<p>Increasing coverage with due consider to the existing collection and transportation.</p> <p>Increasing number of waste transfer stations for effective collection.</p> <p>Researching the capacity of collection vehicle for effective transportation.</p> <p>Timing/scheduling and vehicle routing for waste collection and transportation.</p> <p>Providing technical assistance and financial support for composting in each municipality.</p> <p>Improving and rehabilitating of existing composting plant.</p> <p>Encouraging application of individual composting at each household.</p> <p>Increasing cost recovery for operation and maintenance.</p>	<p>Improving coverage gradually along with promotion of public awareness.</p> <p>Approaching the privatization of collection and transportation service for better efficiency.</p> <p>Promoting the separation collection for effective utilization of recyclable material.</p> <p>Establishing modern transfer station by utilizing old meeting points.</p>
Intermediate treatment	<p>Limiting the open burning at landfill sites and households.</p> <p>Improving for the operational management of existing incinerators and building proper incineration technologies for healthcare waste and hazardous waste.</p> <p>Prohibiting strictly illegal dumping.</p> <p>Improving the operational management of existing landfill sites, especially proper soil cover, bad smell, and leachate treatment.</p> <p>Building and expanding sanitary landfill to prevent the discharge of pollutants from landfill site.</p> <p>Building consensus for regional landfill among the contributing municipalities.</p>	<p>Introducing recycling facilities on various materials.</p> <p>Establishing sufficient market for consuming of the composting product.</p> <p>Organizing recycling routes for recyclable materials.</p> <p>Increasing consideration of effectively centralized composting facilities</p>
Final disposal	<p>Establishing an institutional system for promoting 3R facilities by internalizing informal recycling system.</p> <p>Introducing tariff system based on various recyclable wastes.</p> <p>Introducing incentive scheme in MSW management activities to private sectors.</p> <p>Increasing human resource development through specialized training at various levels of the existing SWM institutions.</p>	<p>Researching proper reclamation plan for using landfill sites.</p> <p>Utilizing the methane gas produced in the landfill as energy recovery.</p> <p>Establishing modern landfill technologies by utilizing old open dumping.</p> <p>Approaching Clean Development Mechanism (CDM) to credit Certified Emission Reductions (CER) for earning money.</p> <p>Developing projects on incineration for treating hazardous and industrial wastes.</p> <p>Selecting suitable site and investing infrastructure for solid waste treatment and disposal sites.</p> <p>Building centralized and shared facilities for proper treatment of hazardous wastes with feasible technologies.</p>
Institutional and financial aspects	<p>Increasing investment in operation and maintenance of SWM systems.</p> <p>Increasing public awareness in environmental sanitary through community media.</p> <p>Initiating environmental education for primary pupils, students.</p> <p>Increasing public participation on waste collection as well as the monthly fee.</p> <p>Expanding National monitoring of solid waste to urban areas.</p>	<p>Establishing deposit system for promoting 3R facilities at local level.</p> <p>Subsidizing for private sector engaged in 3R activities.</p> <p>Establishing private sectors in MSW management services.</p> <p>Courting and utilizing training, exchange of experience, technology transfer and technical assistance funded by government, NGOs, international organizations, etc.</p> <p>Increasing fee level and fee collection rate.</p>
Public participation and Environmental education	<p>Setting up master plans for domestic, industrial and hazardous waste management for near future.</p> <p>Researching and implementing the pilot projects for waste separation at source.</p> <p>Researching and setting up the solid waste charge system for collection, transportation.</p> <p>Strengthening inspection and enforcement activities on solid waste facilities concerning.</p> <p>Enhancing hazardous waste management regulations and practices.</p>	<p>Implementing environmental education for each level of education system.</p> <p>Establishing waste recycling system at source and local level.</p> <p>Developing of community based waste management system.</p> <p>Sharing experiences in waste minimization, recycling, reuse, and composting.</p>
Legislation and policies	<p>Setting up policies on private sector of SWM</p> <p>Establishing and modifying legal documents for promoting the existing SWM system in detail as waste separation, collection, transportation, transfer, disposal and recycle.</p> <p>Establishing and unifying the guideline for waste analysis, monitoring method, classification catalogues, and other requirements.</p> <p>Applying and expanding the successful projects of waste separation at source for from beginning pilot projects.</p> <p>Researching and implementing relocation of heavy pollution industries.</p> <p>Establishing treatment guideline for hazardous waste from various sources.</p>	<p>Setting up policies on private sector of SWM</p> <p>Establishing and modifying legal documents for promoting the existing SWM system in detail as waste separation, collection, transportation, transfer, disposal and recycle.</p> <p>Establishing and unifying the guideline for waste analysis, monitoring method, classification catalogues, and other requirements.</p> <p>Applying and expanding the successful projects of waste separation at source for from beginning pilot projects.</p> <p>Researching and implementing relocation of heavy pollution industries.</p> <p>Establishing treatment guideline for hazardous waste from various sources.</p>

**Public participation and environmental education:** To promote public participation in the MSW management as far as the cleanliness and waste discharge from each household is concerned, the environmental education is quite important. Usually, the adult may not be easily motivated and the opportunity for taking education is restricted if compared with the children. The environmental education for children can be effectively carried out, especially by introducing related subjects in school curricula. Therefore, environmental education on SWM is proposed to be implemented for school children in Vietnam.

**Legislation and policies:** The legislation and policies for environmental management is being developed and implemented in Vietnam. Based on the existing legal documents and policies those promote the environmental management; especially, solid waste field for sustainable development should be rehabilitated existing issues, set up and established new issues for suitable implementations with the current status and further requests. Besides, the regulation suffers from major gaps in enforcement and weakness of institutional framework, such as unclear mandates, fragmented and overlapping roles of various government agencies, and limited interagency coordination. As a result, the state oversight of solid waste is insufficient. In order to achieve the improvement, a detailed action plan is presented in Table 6.

## **CONCLUSION**

As the strong economic growth, urbanization and industrialization rates in the recent years, Vietnam have promoted the issue of solid waste management to the top of environmental challenges. Solid waste generation in Vietnam is increasing rapidly; the main source of waste is domestic that contain high organic content. The waste storage is not similar that cause for uncollected waste in public place, except the healthcare waste container. There is also a lack of proper space to place transfer stations and there is no fixed route map for transportation. However, waste collection is satisfactory (70–90%) compared to the processing of collected waste and the mainly collecting vehicles are handcarts. Besides, URENCO is not cover 100% of the collection areas and the remaining is conducted by private sectors. In order to improve the collection, transportation, transfer and disposal of solid waste in Vietnam, URENCO and private sectors should work together and improve the existing legislation and policies on waste management.

In order to improve the situation, there is an urgent need to act strategically on improving of overall MSW management system. The strategic actions include variety of management aspects such as collection and transportation, intermediate treatment, final disposal, institutional and financial aspects, public participation

and environmental education, and legislation and policies. Moreover, the efficiency of MSW collection and transportation should be improved through increasing the coverage and to find cost effective system. A composting is the most appropriate treatment for MSW generated in Vietnam and it needs to be promoted further. Final disposal with an open dumping practice should be strictly prohibited and accordingly there is a need to improve the existing sites. Public-private partnership is required to ensure sustainability of MSW management system. The insertion of environmental education into school curricula could be an effective way to promote public awareness on MSW.

Moreover, Waste in Vietnam contained high rates of organic matter and moisture content, waste to energy facilities in the form of composting plants and bio-gas recovery landfills may be the most viable option. The 3 Rs – reduce, reuse and recycle – method of waste minimization can also be used to address the growing waste problem. The recycling sector in Vietnam is very active, providing a good basis for increasing rates of reuse and recycling. Another method that is currently not practiced on a wide-scale is the sorting of trash – whether at the source or before it reaches the landfills. Waste minimization may be the most feasible scheme because it requires the least capital investment and relies mainly on either the waste operators and/or the waste generators.

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