

Environmental Management Measures and Current Practices In Solid Waste Management: A Case Study from Vientiane, Lao People's Democratic Republic

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This study identifies and assesses the general practices and environmental measures used in solid waste management in Vientiane, including market and nonmarket instruments as well as public education and training programs (moral suasion). It offers policy recommendations to concerned authorities including effective instruments to minimize the polluting behavior of individuals and industries and to recover the cost of pollution in the city. Interviews with key stakeholders, group discussions with city residents, and observations of existing practices in Vientiane revealed the following problems: weak financial status; insufficient number of staff and facilities; open burning of waste without segregation; use of open dumpsites that pose health and environmental risks; dumping of waste on the bank and in the tributaries of the Mekong River; and low awareness about solid waste management among residents. The problems are further compounded by a high rate of rural-urban migration, the uncontrolled growth of industry and businesses as well as recent changes in the consumption patterns of residents. To improve solid waste management in Vientiane, a combination of market-based and persuasive instruments is recommended. The results of the study may be used by policy makers and agencies in Vientiane as well as by other small cities in the Greater Mekong Subregion.

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I. Introduction

In the Greater Mekong Subregion (GMS)¹, the Lao People’s Democratic Republic (Lao PDR) and Cambodia have the highest population growth rates (2.5%) (Table1). One of the most adverse impacts accompanying the advancement in economic growth, industrialization, and urbanization in the GMS is increasing rate of solid waste (SW) generation in urban areas. Vientiane City is no exception, although its waste problem is not yet as severe as that in other big cities of the GMS. Among the capitals, the rate of solid waste generation is highest in Bangkok, followed by Kunming and Vientiane. In many countries that are experiencing rapid economic development, the problems associated with SW production and management are not addressed until they are already posing a serious threat to advancement. Governments now increasingly realize the need to deal with the growing problems created by solid waste long before they become overwhelming.

Table 1. Population Growth Rate, Urban Population, and Solid Waste Generation in Greater Mekong Subregion Countries

Country	Capital City	Population Growth Rate (%)	Urban Population (%)	Solid Waste Generation in Capital City (kilogram/day/capita)
Cambodia	Phnom Penh	2.5	27.7	0.46
Lao PDR	Vientiane	2.5	15.9	0.70
Myanmar	Yangon	2.3	21.6	0.45
Thailand	Bangkok	0.8	20.0	1.60
Viet Nam	Hanoi	1.6	18.3	0.45
Yunnan Province	Kunming	1.2	24.0	0.79

Source: ADB-UNEP, 2004

Vientiane Municipality is divided into nine districts: five are rural (Sangthong, Naxaithong, Xaithany, Pak Ngum, and Hatxaifong) and four are urban (Sikhottabong, Chanthabaul, Sisatthanak, and Xaysettha). The population of Vientiane is about 600,000 with an annual growth rate of 4.3% which is much higher than the national level (2.5%).

Five major cities have some form of SW collection system in Lao PDR including Vientiane. Among those, Vientiane has the highest rate of waste generation at 4.92 kilograms/week/capita followed by Luangprabang at 3.88 (Norwegian Agency for Development Cooperation 1998). The SW generation rate of Vientiane is also higher than that of Hanoi, Phnom Penh, and Yangon (Table 1).

¹ Cambodia, Yunnan Province and Guangxi Zhuang Autonomous Region of the People’s Republic of China, Lao PDR, Myanmar, Thailand, and Viet Nam.

Vientiane covers an area of 180 kilometers² along the banks of the Mekong River. Its population has been growing rapidly, causing strains on the environment and on the quality of urban environmental services. As the heart of the country's economic, educational, industrial, and business activities, it is confronted by many environmental problems in general and by solid waste problems in particular. Although it has a slower industrial growth rate than other GMS cities, household waste is becoming a big environmental concern. Open and dispersed depositing of solid waste in dumpsites is a widely practiced method of disposal in Vientiane. This has contributed to water and air pollution and to the spread of diseases carried by insects, rodents, and other vectors that come into contact with open dumpsites.

Vientiane Municipality charges flat monthly fees for waste collection, a practice that does not encourage people to minimize its volume. The effective implementation of environmental management measures is necessary to improve the financial base of the municipality, but economic and policy instruments do not seem to function well. Very low revenues generated from households and from commercial institutions as well as small and irregular subsidies from local and national governments hinder the effective management of solid waste in Vientiane.

A. Rationale

Solid waste management (SWM) is a major environmental concern in all cities including those in the GMS. In some GMS cities where environmental management measures are implemented, traditionally responsible local governments (municipalities) manage it exclusively in the commercial sector, yet domestic or household waste accounts for more than 70% of the total volume produced.

Lao PDR is a signatory to Agenda 21, the agreement reached among nations participating in the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. Agenda 21 emphasized that reducing wastes and maximizing environmentally sound waste reuse and recycling should be the first steps in waste management.

The waste collection capacity of the Vientiane Municipality is about 120–130 tons/day, which is only half of the actual rate of total waste generated in one day (Sanasisane 2002). Half of the waste therefore remains uncollected and is left on road corners or is openly burnt or disposed of improperly.

A study by the Japan International Cooperation Agency (JICA) (1992 cited in Sanasisane 2002) stated that SWM in Vientiane Municipality has become a critical problem for the following reasons.

- As the largest city in the country and with a high rate of urbanization, it is the country's center of important activities.

- It lacks resources and technical expertise to deal with the growing waste problem.
- Institutional and administrative structures are not well established.
- Waste collection vehicles are old, insufficient, and subject to frequent breakdowns.
- The public education system for and participation programs in SWM are not well organized.
- Almost half of the total waste is not routinely collected because of resource constraints of the municipality.
- A large portion of waste is illegally dumped into the Mekong River and into existing drainages.
- Crude and open dumping in existing disposal sites causes numerous environmental problems.

SWM systems have been set up in all four of Vientiane's urban districts, all of which have growing urban populations and consequently increasing amounts of waste. Faced with shortages in financial and human resources, the government has tried to involve communities and the private sector in addressing the problem. Nevertheless, SWM in Vientiane is generally considered environmentally ineffective and insufficient for public health and sanitation. Technical managerial solutions to the problem often fail due to complex economic and cultural factors, to lack of financial resources, to institutional gaps, and to ineffective policy instruments. In the end, however, solid waste disposal basically depends on people's behavior.

The United Nations Development Programme (UNDP) (1996) warned that the environmental problems related to SW especially in urban centers of Lao PDR were becoming more and more evident as consumption patterns changed and the economy expanded. These problems have not reached the proportions of those in neighboring countries, but municipal waste in Vientiane polluting the Mekong River and its tributaries has created many environmental problems in the region. In addition to this, the present development trends in Lao PDR have led to rapid rates of urbanization, rural to urban migration, and expansion of the industrial sector, all of which will bring an exponential increase in SW-related environmental problems in the near future. There is a great need to address these issues long before it is too late to remedy the problems they create.

B. Objectives

The overall objective of this paper is to discuss the current practices of SWM in Vientiane, Lao PDR. The paper in particular describes:

- the effectiveness of implemented market and nonmarket instruments;
- public education and training programs (moral suasion) in use;
- general practices of SWM (waste collection, separation, dumping, treatment, disposal);
- policy recommendations to concerned authorities including effective instruments to minimize polluting behaviors of individuals and industries and to recover the cost of pollution to the city.

II. Environmental Management Measures: Experiences in other Countries

A study in the People's Republic of China, Indonesia, Malaysia, Philippines, and Thailand argued for the adoption of market-based instruments (MBIs) as complementary tools for environmental protection in the Asian context of rapid industrialization and emerging economic and financial systems (Chen and Bacareza 1995). The authors also identified four reasons for the adoption of MBIs in developing countries. First, MBIs can achieve the desired effect at the least possible cost as implementing them entails lower information, monitoring, and enforcement costs. Second, economic instruments are easier to enforce than command and control (CAC) regulations in countries with limited enforcement capability. Third, economic incentives will tend to discourage rent-seeking behavior due to their transparent nature. Fourth, economic instruments generate revenues whereas regulations require bloated bureaucracies.

A strong MBI decentralizes decision making to a degree that the polluter or resource user has a maximum amount of flexibility to select the production or consumption option that minimizes the social cost of achieving a particular level of environmental quality (Huber et al. 1998). Eskeland and Jimenez (1992) state that MBIs provide equal incentives to all by increasing the marginal cost of polluting. With many heterogeneous polluters and weak public administration, CAC policies are not effective in implementation. The authors conclude that MBIs provide greater certainty about abatement costs which are superior when there are concerns that underestimating costs would yield controls that are "too strict" and environmental quality that is "too high." Such concerns trouble policy makers in many developing countries. Empirical studies

in the United States (US) show substantial efficiency gains associated with using MBIs rather than non-MBIs (United Nations Environment Program 2004). In the same report, Tietenberg suggested that non-MBI approaches to regulate pollution were 22 times as expensive in the US as the least costly MBIs.

Gerhard (1994) carried out a study on waste minimization and recycling strategies and their chances of success by using different scenarios combining ecological and economical aspects with facts and trends in human ethnology. He found that the household waste fraction could be reduced 10% by recycling. He also concluded that waste minimization and recycling could be successful given the cooperation of different public educational programs on waste management. Taipei, China has implemented several types of recycling systems for polyethylene bottles, glass bottles, aluminum cans, waste paper, used tires, lubricating oils, mercury cell batteries, and pesticide containers. Similarly, the Republic of Korea has also proposed an ambitious deposit-refund system for a wide range of products. One of the few cases of mandatory deposit-refund systems is found in Mexico (Huber et al. 1998). A new car battery can only be sold there with the return of an old one as batteries are considered highly hazardous waste and are very difficult to dispose of.

A study in Olongapo City of the Philippines (Bennagen and Altez 2004) found that shifting from the existing flat-fee structure to unit pricing for SW diverted at least 30% of the garbage through various alternative waste management practices such as household recycling and managing food wastes. In the 1990s, the Malaysian government introduced MBIs for pollution control (with effluent charges and licensing fees) according to the quantity of waste discharge (O'Connor 1996). Beginning the second year of the intervention, the pollution loads to the city decreased by 25%. In Guayaquil, Ecuador and in Colombia, a SW collection fee is applied as a 10% surcharge on electricity bills (Huber et al. 1998). Although it may not include rationalization of waste generation, the collection costs for such a scheme are low and effective. This definitely saves time and manpower in collecting users' fees from the households in the city.

III. Solid Waste Management in Vientiane

A. Laws, Regulations, Jurisdiction, and Agencies Involved with Solid Waste Management

A number of laws, guidelines, and regulations have been made in Lao PDR that deal directly with solid waste management. These are:

- The Environment Protection Law of Lao PDR 1998;
- Decree on the Management of Solid Waste and the Cleaning of Public and Residential Areas;
- Regulation on the Monitoring and Control of Waste Discharge (No.1122/STENO) 1998;
- Guidelines for Hospital Waste Management (1997);
- Industrial Waste Discharge Regulation (No.180/MIH) 1994.

After the 1992 Rio Earth Summit, Lao PDR established the Science, Technology and Environment Organization (STENO) directly under the Prime Minister's Office. Within STENO, the Department of Environment (DOE) is delegated the specific task of environmental management while other STENO departments deal largely with science and technology issues. STENO/DOE oversees policy formulation and the coordination of environmental protection efforts.

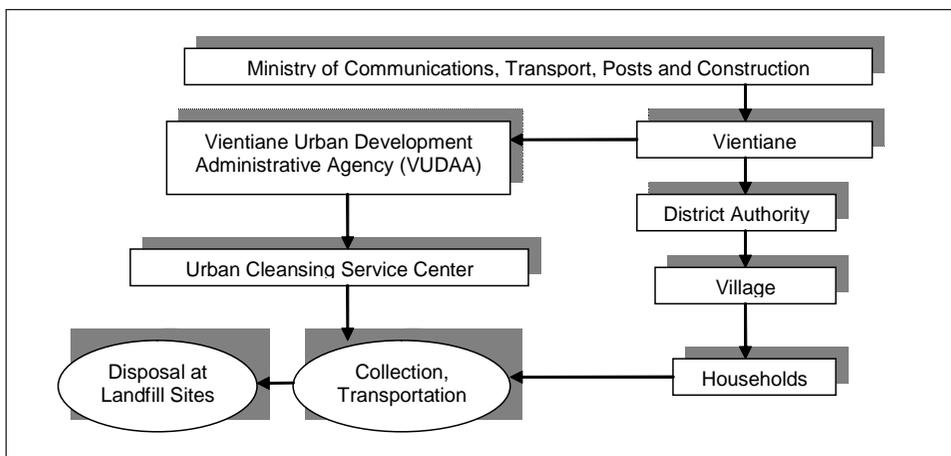
The DOE consists of two divisions: the Policy and Programs Appraisal Division (PPAD) and the Regulation and Compliance Monitoring Division (RCMD). PPAD is tasked with the formulation of national environmental policies employing policy inputs and technical assistance from the other ministries. RCMD is responsible for overseeing the legal and regulatory framework on environmental management issues.

According to the environment protection law, authority to manage solid waste lies with STENO at the national level and with environmental management and monitoring units at the ministerial, provincial, special zone, municipal, district, and village levels. The Ministry of Communications, Transport, Posts and Construction (MCTPC) is responsible for SWM; the Department of Communications, Transport, Posts and Construction represents MCTPC at the provincial level; and municipal administrations are responsible for SWM at the local level. The joint supervisory committees from provincial and district administrative offices are usually responsible for implementing SWM programs.

B. Solid Waste Management in Vientiane

Figure 1 outlines the responsibilities for solid waste management in Vientiane. MCTPC has dealt with SWM since 1992 with financial support from JICA. In 1995, SWM (collection, transportation, and disposal) was handed over to Vientiane Municipality, specifically to the Vientiane Urban Development Administrative Agency (VUDAA) that was established by Prime Ministerial decree in 1999. According to the decree, the VUDAA has responsibilities for planning, operating, managing, and maintaining local government infrastructure services and environmental management programs. It operates under the VUDAA Board. VUDAA consists of five divisions including the Technical and Urban Planning Division and the Environmental and Sanitation Division. The latter is responsible for SW collection, for transportation, for septic effluent, for sludge collection, for treatment programs, for inspecting licensed premises, for care of parks, for street cleaning, and for monitoring implemented programs.

Figure 1. Organizational Structure of SWM in Vientiane



Source: VUDAA

The Urban Cleansing Service Center (UCSC) was established under VUDAA administration to collect, transport, and dispose of SWM in Vientiane. The center has been working since 1998 in coordination with the municipality and JICA. It provides more than half of overall municipal cleansing services which include cleansing and waste collection from schools, markets, hospitals, and commercial centers. It is also responsible for disposal of collected waste after treatment. In addition, JICA implemented the 1-year project on the “Improvement of the Solid Waste Management System in Vientiane Urban Area.” (UNDP 2001) The project was supposed to provide heavy equipment and a maintenance workshop seven kilometers away from the core

city, to improve the waste disposal site 18 kilometers outside of the city, and to provide safe drinking water to the people living in the area near the dumpsite.

Three other agencies, the Lao Garbage Company (private), the Vientiane Development Company, and the Participatory Development Training Center (PADETC) are also involved in various activities in urban waste management in Vientiane. PADETC provides integrated waste management programs for youth in schools and communities. People, mostly youth, are operating PADETC on a voluntary basis and are getting some financial support from the Embassy of the Netherlands. Similarly, the Asian Development Bank and the German Development Bank are also assisting Vientiane Municipality to improve its SWM system in conjunction with other urban development programs. In addition, the Ministry of Public Health and the World Health Organization are jointly promoting a project for the treatment of hazardous and infectious waste in the city.

C. Waste Collection, Disposal, and Recycling

Currently, UCSC, the Lao Garbage Company, and Chanthabouly Cleansing Pvt. Company (also private) are jointly handling city waste in Vientiane. One nongovernment organization (NGO), the Lao Women's Union, is conducting educational and training programs for waste pickers in the city with support from the SWM for Vientiane Poor Project. The programs focus on topics such as how to handle hazardous waste in the waste stream and how to add value or generate income from collected wastes.

Vientiane Municipality has 30 garbage trucks, 8 of which are hi-tech, close-type compactors; the remaining 22 are open trucks. These are a mix of new Japanese trucks, reconditioned French waste collection vehicles, and locally purchased vehicles. Around 50 administrative staff and 150 waste collectors (field workers) are engaged daily to collect, transport, weigh, and dispose of waste. UCSC has 75 staff working on SWM in the city and allocates five workers per truck to handle solid wastes. The charge for waste collection from households ranges from 10,000 to 20,000 kip (US\$1–2) /month depending on the frequency of collection. Garbage is collected twice a week in the core city but only once a week elsewhere.

Bamboo bins and polyethylene bags are generally used to store garbage in household areas and waste collection points in market and office areas. The municipality has installed 50 large containers around the city to collect large volumes. The bamboo bins are returned to the households after the contents are deposited in landfill sites and as workers come back to collect waste the following week.

A waste separation and recycling initiative led to the establishment of recycling banks in the name of the Integrated SWM Project and the Lao Chareon Recycling Center. Supported by the Royal Dutch Embassy and German Technical Cooperation, the initiative aimed at creating a sustainable and culturally appropriate system for SWM

in Vientiane. Currently, there are 30 recycling banks operating in Vientiane—20 in communities and 10 in schools. Initially, the municipality provided a budget of 500,000 kip (US\$50) for each community to construct banks for waste collection and to operate the project. The communities sell their waste to the recycling center once the waste banks are full. In the schools, students and teachers are operating and managing the recycling banks as an extra-curricular activity. They bring recyclables from their homes once a week to deposit in the school bank. When the bank is full, they contact a private company to come and buy their recyclables. They then distribute the income among themselves and the school administration proportionately.

Community recycling banks are jointly managed by a chief, a storekeeper, a cashier, volunteers, and community members. The bank “staff” and volunteers encourage and motivate people to attend activities such how to compost, how to reuse materials, fashion shows on recycling materials, and how to sell reused materials. Community members (adults and children) deposit their recyclables in their bank accounts. When the bank is full, the staff contacts the companies that will come to collect/buy the contents. The bank manager then distributes the proceeds to members in accordance with the amounts they deposited.

The KM 7 Waste Buying Company (supported by a Thai company) and the Lao Chareon Recycling Center, both private enterprises, are major centers that successfully collect recyclables. They received training at the Wongpanit Company in Thailand and follow-up training and support from PADETC. They buy recyclables from waste pickers, from school waste banks, from other similar groups, and from individuals and sell their materials in Vientiane. The recyclables ultimately go to Thailand and Viet Nam.

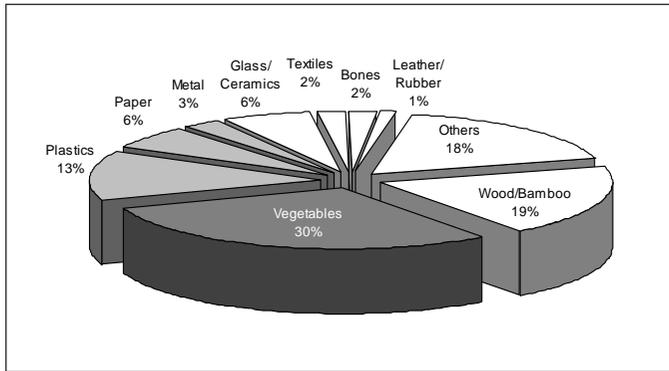
The Lao Chareon Recycling Center located 8 kilometers from core Vientiane was established with an initial investment of US\$10,000. It claimed to have gained a net income of US\$18,000 by 2001 (Dethoudom 2004). The company is financially sound and expanding its business every year. At the initial stage, the company bought recyclables from waste pickers at landfill sites. Later it started to buy from community and school recycling banks, from scavengers, from project groups, and from individuals from different parts of the city. The company is also promoting environmental protection and income-generating programs by training local people and familiarizing them with the value of waste. The company now has more than 150 employees and is the biggest recycling center in Vientiane.

D. The Composition and Sources of Solid Wastes

Implementing environmental monitoring and management of solid waste also depends on its composition (e.g. recyclable vs non-recyclable wastes). Figure 2 shows that food and vegetable wastes comprise 30% of the total generated in Vientiane followed by recyclable items (paper, metal, and plastics) that account for an additional 22%. About

30% is organic waste and can be composted. Composting solid wastes reduces (i) the level of leachate production by recycling the organic fraction of the waste stream, (ii) the total amount of waste by diverting some for alternative use, and, (iii) the overall cost of SWM and protecting the urban and nearby environment.

Figure 2. Solid Waste Composition in Vientiane, Lao People’s Democratic Republic

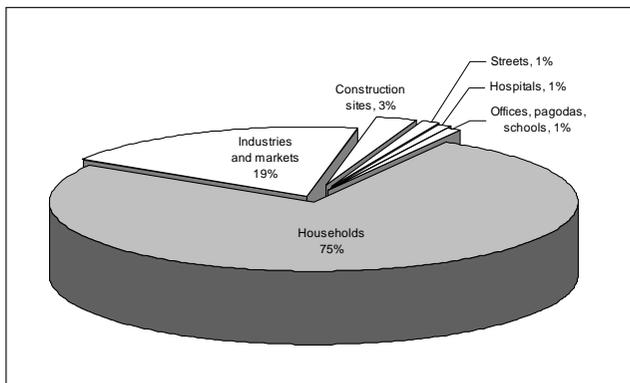


Source: Norwegian Agency for Development Cooperation (1998, Options for the recycling of plastic in Lao PDR)

Figure 3 shows that household waste makes the largest contribution to solid waste generation in Vientiane (75.8% of the total) followed by industrial and market waste at 19.1%.

Since households are responsible for most of the waste generated in the city, community participation is essential for effective SWM. As mentioned previously, the municipality, with the cooperation of the private sector, has established 20 recycling banks in communities and 10 in schools.

Figure 3. Waste Generation in Vientiane by Source



Source: Urban Cleansing Service Center

IV. Solid Waste Management: Approaches and Problems in Vientiane

A combination of government and private companies collects waste from different parts of the city. The municipal administration dictates collection frequency and charges to households and commercial institutions. Up to now, there has been no proper SWM system to solve problems of collection, recycling, reduction, reuse, transformation, and disposal. The city's inhabitants generally perceive the waste problem as a minor one and lack awareness of its importance and seriousness. They therefore make no efforts to reduce waste. Collection services reach only a small proportion, possibly 10%, of urban households in Vientiane due to the following reasons.

- Private and public services are under-financed.
- Households are reluctant to pay the monthly waste collection fees because the services provided to them are inefficient.
- Collection services are unreliable usually due to insufficient and poor maintenance of equipment.
- Public awareness of the importance of waste disposal is lacking (UNDP 2001).

The following problems of solid waste management in Vientiane were observed.

- Waste collection is not efficiently planned and does not reach all communities. In most places, the municipality is collecting waste only once a week, a practice that has created illegal dumping.
- Urban dwellers face health risks and environmental damage caused by inappropriate handling of waste (open burning of uncollected waste, throwing of waste on the banks of the Mekong River). Marginalized and minority groups are the most vulnerable to pollution. These low-income communities are exposed to higher environmental risks than other groups in society as they often live in more polluted and industrial areas and may not have ready access to health care services. Coordination between and among the municipality, residents, the private sector, and waste collectors is lacking.
- Open dumping is difficult to monitor and has polluted natural streams and tributaries and created high health risks for human beings and livestock.
- The vehicles for waste collection are insufficient for reaching all communities.
- Users' fees are too low to compensate the municipality for the cost of SW collection and disposal. As a result, public and commercial institutions are

not internalizing the externalities, and the municipality is poorly equipped financially to efficiently manage its solid wastes.

The choice of instruments to internalize the externalities of urban pollution depends on the local context such as geographical region, people's behavior, previous trends, and administrative structures. Many MBIs, non-MBI's and persuasive instruments exist and in fact are used to manage solid wastes in Vientiane. Their features and implementation are discussed below.

A. Market-Based Instruments

MBIs for SWM in the form of taxes, user fees, service charges, and fines are very popular in many cities worldwide because they are easy to implement, they strengthen the financial base of SWM institutions, and because they attempt to shift the costs of and responsibilities for pollution back to the polluter. MBIs aim at internalizing environmental externalities by setting costs and benefits to influence decisions and behaviors towards more environmentally desirable situations. They offer advantages because they are economically efficient, easily modified, and ultimately lead to better allocation and use of resources. In addition, MBIs can be effectively introduced even if the administrative structures of SWM are not efficient. On the other hand, some researchers question the validity of MBIs arguing that they allow people to “pay to pollute” since every household and commercial institution may generate any amount of waste and then pay the charge.

In Vientiane, the municipality charges flat fees for waste collection but does not charge for waste disposal though in reality disposal requires more technical expertise and effort. Waste collection fees for households average about US\$1–2/household/month. The rates for commercial institutions are higher but are still very low relative to their contribution to pollution. In line with the principle of the polluter pays, the local authority should increase fees and service charges for waste collection to encourage people to minimize, recycle, or compost their waste. Waste disposal fees should also be introduced. These two measures will strengthen the financial base of the municipality and ultimately enable efficient and sustainable management of solid waste in Vientiane.

According to the Solid Waste Management for Vientiane's Poor Project (2005), around 300 waste pickers are currently working—100 in the city and 200 in the landfills 18 kilometers away. Only 150 are registered. Waste pickers contribute a lot to minimizing volume, so they should be given incentives to continue their work. Educational programs for waste pickers should also be organized to include topics such as safety measures for handling dust, smoke, and infectious waste. The living standards of the waste pickers should be improved by providing them with regular incentives and encouragement from the municipality.

Voluntary deposit-refund systems for glass, paper, and plastic and the recycling of ferrous materials, paper, and plastic are well established MBIs in various parts of the world. Both instruments have considerably decreased the total volume of waste produced. The deposit-refund system is popular for beer and soft drink products in which packaging costs have a higher share of the total product price as the return rates are also high. In the case of wine and other liquor products, however, the packaging cost is a lower share of the total price, therefore the return rate is low and the deposit-refund system is not commonly used. Refunds for aluminum cans are now increasingly popular in various parts of the world due to their high value added from recycling and to the expanding use of such containers. Refunds are also appropriate for toxic and hazardous waste management (motor batteries, tires, lubricating oils, etc). Glass bottles (beer, soft drink products) are traditionally returnable in Vientiane. In the case of beer bottles, a deposit of 1,000 kip (US\$0.10) is required. Residents currently donate water bottles, cleaning bottles, plastic soft drinks bottles, and car batteries to dealers and waste pickers. Broken glass collected by scavengers is sold to the recycling centers at the nearest point and then exported to Thailand and Vietnam. Iron, steel, and other metal wastes are expensive to export as the government has imposed more duties on these materials. There are definitely possibilities for wider recycling of glass, plastic, motor batteries, lubricating oils, and metal beverage containers. The government could also encourage public offices to use recycled products.

Subsidies for recycling industries are the most encouraging tools of MBIs. Land can also be offered at a lower cost to encourage investors to establish SWM technology in the city. Along with subsidies, local and national governments should create a market for recycled products to ensure sustainability. Tax waivers and subsidies to establish recycling industries will attract private sector and NGO investment in SWM. Waiving taxes for the establishment of new plants and technologies and offering tax holidays for certain time intervals will also attract investment. Higher duties on imported products will help to create a market for recycled products. The use of compost instead of chemical fertilizer is a good example (see the box on the next page). The local or national government can create a market for compost by imposing higher duties or fixing quotas on imported or locally produced chemical fertilizers. The composition of SW in Vientiane (see Figure 2) reveals a high potential for making compost from organic matter after sorting and appropriate biological treatment and recycling of paper and plastic products. With composting, it seems feasible to reduce waste volume by 49%. Stakeholders should provide education and subsidies to residents who compost.

Small-Scale Composting at the Community Level: The Thai Experience

The growing volume of waste generated by the rapid urbanization of Pakkret municipality of Nathaburi Province, Thailand, led to a cooperative effort to reduce household wastes. With the help of the Japanese Embassy, in 2004 the villagers established a recycling center covering 240 households. The center consisted of an office building, a composting plant, and a sorting area for recyclables. The staff collects household wastes in a small van, buys recyclables, makes compost, and serves as a liaison between the Pakkret municipality and the villagers.

Biofertilizers are produced using a rotary drum (Japan International Cooperation Agency technology) with a capacity of 300 kilograms/day. After collection, waste is cut into small pieces using a hand machine and a mix of ingredients (65% biowaste, 25% biofertilizer, and 10% sawdust) that reduces moisture content. The mix is then fed into a rotary drum operated three times a day at three rounds at a time to mix and aerate waste for quick fermentation. The mixture is pushed through the inner chamber of the rotary drum from 2–4 weeks for fermentation. Secondary fermentation takes another 2–3 weeks. Only 20% of the villagers are involved. There is a future plan to expand the production of biofertilizers to other villages of the municipality.

B. Non-Market Based Instruments

Non-MBIs are also referred to as CAC or regulatory measures. They include the following:

- technology standards;
- pollution standards;
- land use restrictions;
- environmental guidelines;
- quota systems;
- city zoning;
- waste collection times;
- standards for dump sites;
- frequency of waste collection;
- permits and licenses for hospitals and construction firms;
- control of indiscriminate use of land and water bodies for waste disposal;
- different kinds of SW plans and regulations.

Setting the standard for garbage collection bins should be addressed in Vientiane. Locally made bins, plastic bags, and plastic bins widely used for waste collection are not safe as they do not control bad odors, and they attract birds and stray dogs. They also occupy a significant amount of space along principal roadsides. Standards for dumpsites are another non-MBI that could be adopted. Vientiane municipality currently does not have a sanitary landfill; wastes are deposited in open dumpsites.

Regulations on SWM have been addressed in some measures like the environmental protection law. Although there is provision for permits and licenses for hospitals, commercial establishments, and construction firms, the revenue generated from them is not allocated for SWM and for protection of the urban environment as the municipality does not have sufficient resources, expertise, and manpower to do so.

Non-MBIs require much more detailed information on regulating firms, industries, and other commercial institutions than MBIs require. Vientiane does not have the information, expertise, or technological capacity to set standards for waste collection, waste disposal, vehicles, technology, pollution, land use restrictions, licensing of economic activities, etc. Non-MBIs generally set fines or penalties that are frequently too low to deter violators. Sophisticated regulatory compliance staff and support are required for them to be effective.

Both public and commercial institutions believe that the management of SW is the sole responsibility of government. Involving the private sector and non-profit organizations will change the behavior of the public and will create better alternatives for SWM. The private sector can be encouraged to enter into the business of collection, recycling, and disposal by providing incentives and soft loans for purchasing equipment. Government laws and regulations should clearly define the responsibilities of personnel, government organizations, and the private sector.

Some residents are reluctant to pay for existing SWM services because of their irregularity. This may suggest a need for improvement in management, specifically an increase in the frequency of collection and disposal to at least three times a week. The increase should be done in conjunction with setting standards for collection bins and for biological treatment of waste in dumpsites. The municipal administration can also relocate commercial institutions outside of the core city and can limit licenses to new industries that produce solid waste. This will reduce the total volume in the most crowded areas of the city.

Non-MBIs require specific expertise to set standards and to formulate SW policies and laws. The municipality also needs experts to monitor SWM activities. Training will enhance the capacity of municipal personnel to better implement and monitor activities. Study visits can also be scheduled on a regular basis so that municipal or government personnel can learn from improved SWM practices in cities in neighboring countries.

C. Persuasive Instruments

Persuasive instruments are also called moral suasion. Training, awareness-raising campaigns, extension activities, school and college educational programs and environmental education are key elements of any policy in this category. The primary purpose of these instruments is to make people aware of the importance of SWM as they rely on voluntary compliance by polluters motivated either by the threat of adverse publicity or the prospective favorable publicity.

As a result of a JICA pilot project started in 1990, courses or units on domestic wastes and hygiene are now included in school curricula. Environmental education has been mandatory in primary and secondary schools since 2001. At the higher level, the Faculty of Engineering and Architecture of the National University of Laos has conducted a course on environmental management that has included integrated SWM since 1998. The course aims to improve the knowledge of students about the production of goods, its impact on the environment, and how to minimize its negative effects. From time to time, the university's student affairs office also organizes campus-cleaning campaigns to raise students' awareness of solid waste management. These programs should be continued and extended to schools on a regular basis to ensure better understanding of SWM among young people.

Lao television has an SWM educational program (15 minutes a week). The program disseminates messages such as "throw garbage into bins," "cover the mouth of bins tightly," "keep bins away from dogs and pigs," and "do not dispose of garbage in illegal places." *The Vientiane Daily* also has one weekly column reserved for environment-related news and issues. These instruments are useful, but further effort needs to be made to mobilize mass media to raise the awareness of the public (including NGOs and the private sector) about better SWM. Broad community participation is needed.

Waste separation at the source (household) is the main solution to environmentally sustainable SWM, and it can significantly reduce both the cost of collection and the overall cost. In Vientiane, household wastes make up almost 76% of the total volume. If waste separation is successfully implemented, there are many opportunities to collect and utilize the segregated materials. Furthermore, the following activities will yield long-term, positive environmental and socioeconomic impacts:

- regular sharing of information with and raising the awareness of local people;
- training volunteers to educate households in separating wastes;
- expanding community and school-operated recycling banks to all communities and schools;
- continuing and expanding mass media mobilization;
- establishing community working groups to monitor illegal dumping.

Community participation significantly reduces the cost of waste collection. Public awareness about proper SWM is increasing, but the pace is slow. The changing consumption patterns of the city's inhabitants have altered the composition of the waste stream to mostly plastic materials. Clean campaigns and other educational programs can change public attitudes and create environmental awareness and the proper behavior toward minimizing volume. This may involve messages such as keeping garbage bins in good locations; buying goods without unnecessary packaging; returning packaging materials to production sites; returning products for collective disposal; and recycling items such as used furniture and electrical and electronic appliances. The municipality should extend the following messages to improve the awareness and understanding of the SW problems in the city.

- Households should keep different types of garbage in different bins.
- Households should store garbage securely so the municipal people can collect it easily.
- Individuals should buy commodities without unnecessary packaging or should return the packaging materials to the dealers.
- Used items should be returned to dealers for collective recycling or disposal (lubricating oils, furniture, motor batteries, electrical and electronic appliances).

D. Limitations of These Approaches

MBIs and non-MBIs require that local institutions cooperate and promote environmental quality by shifting the costs back to the polluters. MBIs allow market flexibility to control pollution. If the polluters do not reduce their waste, then the local authority can charge higher user fees to encourage them to do so. MBIs tend to price all units of pollution, even the smallest, so that every polluter pays.

Effective monitoring, data generation, and enforcement are often required for non-MBIs to function. Strong and efficient administration to implement pollution standards and expertise to monitor practices and prepare laws and regulations are also needed. It also requires more sophisticated regulatory compliance staff and better functioning administrative and political institutions. Non-MBIs allow people to pollute to a threshold level without charge; MBIs in contrast require the polluter to pay for even the smallest unit of waste generation.

Persuasive instruments aim to change the behavior and attitudes of people toward minimizing their waste and reducing city pollution, but they do not work effectively alone for the management of SW. They need to be reinforced with MBIs or non-MBIs.

V. Conclusions

This study supports the findings of other studies. MBIs for SWM are more effective than non-MBIs in terms of cost management and ease of implementation as MBIs try to shift the cost of pollution back to the polluters and to internalize the externalities by increasing user fees as a function of the amount of SW generated. Non-MBIs, on the other hand, require strong administrative structures to penalize violators and may be less effective in Vientiane.

MBIs should also be combined with persuasive instruments that help change public attitudes towards the handling of SW in Vientiane. Some residents are reluctant to pay for the currently unreliable collection and unsanitary disposal system. Community dissatisfaction with current practices may lead to more refusals to participate and pay fees hence further reducing revenues. Certainly the municipality needs to improve solid waste management services, but it is also necessary to fully effectively use persuasive instruments to complement MBIs. Effective solid waste management calls for the active participation of communities, local governments, and NGOs.

These findings may have implications for other cities in the GMS as they also have the same problems with solid waste and thus face similar challenges. For example, the number of urban poor has increased significantly in both Cambodia and Viet Nam as a result of rapid urbanization. SWM problems in those two countries are attributed to the shortage of (i) skilled and experienced human resources; (ii) appropriate equipment to ensure cost-effective collection and transportation of waste; (iii) accessible finances due to insufficient revenue generation; and (iv) remuneration for workers to encourage effective operation.

There is a need in the GMS cities to modify the current flat-fee structure, to change public attitudes on environmental sanitation, to introduce hygienic practices, and to provide information and education to waste pickers and local residents. In Cambodia and Viet Nam, the Japan Fund for Poverty Reduction Project is promoting community awareness and proper sanitation programs. Local governments are now faced with major issues such as how to finance the infrastructure needed for effective and efficient SWM as well as how to recover the investments related infrastructure, operation, and maintenance. A mix of MBIs and persuasive instruments may be a solution for these GMS cities.

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