

Improving the solid waste management in Phnom Penh city: a strategic approach

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Abstract

Though the solid waste management (SWM) system in Phnom Penh city in general has been upgraded since the waste collection service was franchised out to the private sector, the performance of the existing SWM system is still low. Unreliable and irregular collection service still exists. This means that there are shortcomings in the existing SWM system that need correction. This paper is an attempt to identify those shortcomings in order to find ways to improve the existing system. First, the present SWM system is reviewed. Then the system is evaluated to find constraints and shortfalls and finally some appropriate strategies are proposed that may help make SWM in the city more effective and efficient to meet environmentally sound objectives.

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1. Introduction

It is widely recognized that solid waste management is not only a technical problem but it is strongly influenced by political, legal, socio-cultural, environmental, and economic factors, as well as available resources. Moreover, these factors have interrelationships that are usually complex in the waste management system. It is suggested that appropriate solutions to the complex waste management problems be sought from a system perspective, taking into account all of the above factors in the local area (Mashayekhi, 1993; Vesilind et al., 2002). Failing to do this, solutions proposed to solve solid waste issues may not be effective enough to yield any fruitful results. This is true for the case of solid waste problems in Phnom Penh city.

The municipality of Phnom Penh (MPP), which has the responsibility for SWM in the city, lacks financial re-

sources to operate its own solid waste collection and disposal system. With the public pressure to improve the solid waste service in the city, and due to its financial resource constraints, the MPP has franchised out solid waste collection service to a private company. This certainly solves the cash flow problems of the MPP, as the contractor can recover its costs from the collection of service fees from its customers and thus, there are no direct capital contributions from the municipality. More importantly, the strategy can help the MPP to respond to the solid waste service demands of the city dwellers. This seems to be a considerable achievement. However, the overall performance of the contracted SWM service is still low and littering remains very high. This clearly shows that solving the financial resource issue alone does not mean solving solid waste issues. The solid waste problems prove generally to be much more complex. In spite of this, solutions to waste problems must be found to avoid potential threat to the public health and urban environmental quality in general. Hence, it is necessary to evaluate critically the existing system and develop appropriate strategy to improve SWM in the city.

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2. Baseline conditions

2.1. National priority policy

According to the Socio-Economic Development Plan (SEDP) prepared by the Ministry of Planning (MOP, 2002a), the government strategy to meet the objective of the economic growth focuses strongly on agricultural and rural development, and to support economic growth, the government strategy is to allocate resources to restore and expand critical economic and social infrastructure. The strategy is officially documented in the Public Investment Program (PIP) prepared by the MOP (2002b) that is used by international aide agencies, donors, and development banks for selecting and financing appropriate projects.

The resource allocation to public sectors under the PIP has been split into seven sectors: (1) agriculture, (2) energy, (3) industry and trade, (4) water resource and management, water supply and sanitation, (5) education and training, (6) health, and (7) environment and conservation. Although SWM is included in the environment and conservation sector, the attention to the SWM field does not seem to be adequate. The only SWM project under the current PIP is a new sanitary landfill, and other general issues of SWM system such as improving solid waste service, resource recovery, etc., are not included. It seems that there is a lack of a comprehensive SWM strategy for soliciting external funding.

2.2. Demographic indicator

Phnom Penh, the capital city of Cambodia, has a total population of approximately 1 million which consists of about 0.6 million of urban population and 0.4 million of rural population. The average population density in Phnom Penh is about 3448 persons per km² (MOP, 2001). The population growth in the city and in the country as a whole is shown in Table 1.

According to Table 1, the population growth rate in Phnom Penh city is higher than the average of the whole country. This shows that there may be a rapid population inflow into the city, perhaps because of job oppor-

tunities or other attractive factors. However, more people means more waste, and more waste means more resources needed for waste management. So, the rapid population inflow should be considered in designing a waste management plan.

2.3. Economic indicators

Cambodia for the past 20 years has been classified as one of the poorest countries in the world. Since the election of May 1993, the Royal Government has taken constructive action to change the chaotic macroeconomic setting that has previously existed. There have been some revenue reforms, expenditure control, legislative and regulatory initiatives, a climate more conducive to privatization, and new domestic and foreign private investment. With such reforms, there is a growth trend in the national economy. Table 2 lists some key economic indicators. However, Cambodia is still one of the poorest countries in the world. GNP per capita of the country is less than 280 USD/year. This is not only much lower than an average of Southeast Asia and Pacific Ocean countries (990 USD per capita/year), but is also below the low-income country average (520USD per capita/year) (Mori, 2000). This factor may affect the ability of the public to afford the high standard of solid waste service to be offered.

2.4. Urban waste characteristics

Waste cannot be effectively managed at any level without a good understanding of what it comprises, how much there is, who makes it, what happens to it, and what its effects are (Rushbrook and Finnecy, 1988). For example, without a knowledge of the composition of the waste, it would be difficult to find an appropriate disposal method (e.g., does incineration make sense and should it be introduced into the waste management system?). Similarly, it would be difficult to design a waste collection system if adequate data on the amount of generated waste to be collected is not available. The urban waste characteristics may be conveniently considered under two headings: waste generation, and composition of the generated waste.

Table 1
Population growth

	1986	1993	1995	1998
In Phnom Penh ^a				
Growth rate (%)	11.3	5.4	2.7	–
Population (thousands)	561	810	854	999
In Cambodia ^b				
Growth rate (%)	2.8	3.3	2.5	2.4
Population (thousands)	7762	9653	10,198	11,599

^a Mori (2000).

^b MOP (2001).

Table 2
Key economic indicators for Cambodia

	1996	1997	1998	1999	2000	2001
GDP at current prices (billions of riels)	8271	9125	10,795	11,797	12,149	12,724
GDP at current price (millions of dollars)	3131	3042	2841	3088	3149	3234
GDP per capita (dollars)	273	258	234	248	247	247
Growth rate of real GDP (1993 prices)	6.7	0.7	2.9	6.8	5.5	5.3
Budget revenue (percentage of GDP)	9.1	9.7	8.7	11.2	11.7	12.0
Budget expenditure (percentage of GDP)	17.4	13.8	14.4	16.4	17.3	18.4

Source: CDRI (2003).

Riel: 2003 exchange rate is approximate at 4000 riels per 1 \$US.

Table 3
Solid waste generation in Phnom Penh, 1995–2000

	1995	1996	1997	1998	1999	2000
Waste volume (m ³)	363,703	381,610	380,098	450,963	511,000	584,000

Source: MOE (2001).

2.4.1. Waste generation

This study covers only management of municipal solid waste, that is, waste generated by households, shops, offices, restaurants, hotels, markets and industries (only normal non-hazardous waste), as well as street sweepings. Industries producing hazardous or chemical waste and those engaged in construction and demolition will be expected to organize their own waste collection services based on government regulations.

As mentioned earlier, the estimate of the quantity of waste generation to be handled is crucially important to design collection service and disposal facilities. A grossly inaccurate recording of the amount of waste could lead to over or under-provision of collection services or disposal facilities. Unfortunately, in a developing country like Cambodia, data related to SWM is scarce. Moreover, information sharing among the authorities concerned with SWM is extremely limited.

Up to now, there has not been any rigorous estimate of the waste generation per capita in the city of Phnom Penh. The value of waste generation per capita, 0.65 kg/day, is an assumed value based on the data available in other countries with similar economic situations (Mori, 2000). However, there is an estimate of annual generated waste based on counting the number of trucks that go to the only existing dumpsite. Such an estimate may have a very limited accuracy because firstly, the collection trucks are not always fully loaded as they are supposed to be. Secondly, the uncollected waste left in the city in many areas is not taken into account, so the estimated generated waste may be much less than the actual amount. The amount of generated waste is shown in Table 3. According to data in Table 3, the waste generation in the city has increased over time. Better planning for SWM should be established to avoid any serious outcome.

Table 4
Characteristics of solid waste in Phnom Penh

Parameter	Value
Composition (% wet wt.)	
Organic waste	65
Inorganic waste	
Paper/cardboard	3.8
Plastics	13.2
Metal	1
Glass	4.9
Rubber, leather, etc.	0.6
Other	11.5
Moisture content (%)	50
Density (kg/m ³)	350–400
Calorific value (kcal/kg)	1000

Source: Inter-Consult (2002).

2.4.2. Composition of the generated waste

The results of a survey of composition of the generated waste made by Inter-Consult (2002) are shown in Table 4. The results show that the plastic content is unusually high, probably because it was wet, which increased the weight. Much of this material, according to the report, is in small pieces, mixed types, wet or dirty, making it difficult to be recycled. The results of the analysis also show that the generated waste in the city is largely organic matter that has potential for composting.

3. Introduction of the existing SWM system

The philosophy of this paper is that a patient's illness will probably be effectively cured if the cause of the disease is clearly identified. Similarly, SWM problems may be effectively solved if the shortfalls and constraints are clearly understood. Therefore, it is important to review

first the existing arrangement of the SWM system in the city to find shortfalls and constraints in the system before appropriate strategies can be proposed.

3.1. Existing technical arrangement system

3.1.1. Waste storage

Generally, no system for storing waste in bins or containers at the source of household waste generation has yet been introduced in Phnom Penh. Restaurants, hotels and shops usually use their own bins and containers for on-site storage of the waste, but a standardized system of bins and containers that could be mechanically loaded into a collection truck does not exist.

The municipality has placed public bins made from half-oil drums along some of the major roads for temporary storage of waste, to be used by the public to put small amounts of waste such as paper or wrappings, in order to avoid littering, and to improve the cleanliness and appearance of these areas. Unfortunately, the places where drums have been put become points where people throw their household waste. This shows that the public awareness is still very low. Moreover, though the storage bins are available at some places, the number of bins is far below the number required. As a result, the waste is always seen spilled over and scattered around the bins.

3.1.2. Waste collection and transportation

Waste collection service is available only in some places such as at residential areas with good standard roads, shopping centers, restaurants, and hotels. It was estimated that more than 20–30% (real figures could be higher) of the population in the city is without regular or adequate collection service and the coverage, efficiency and frequency of collection vary substantially from one area to another or even from one street to another street (Mori, 2000). Moreover, the transportation of waste to the dumpsite has not been properly managed. Wastes such as plastic bags or other light materials are clearly seen flying from the trucks during transport. This also contributes to the litter on streets.

It seems that the collection service in Phnom Penh at present is deteriorating rather than improving. In many areas, the collection frequency has dropped from once a day to once every two or three days. In addition, the collection times are quite variable. Residents must wait for the trucks to honk their horns to signal that they are on the street. However, with irregular collection times, people are not always at home or ready to deliver the waste. Consequently, more and more households place their waste outside their houses along the curb or roadside. The waste bags are subject to being torn by scavenging animals that search for something to eat or by waste scavengers who search for saleable materials. These activities usually scatter the waste that is ready for collection, and this makes the job of the collection crew

even more difficult, as they have to shovel the loose and scattered waste from the ground into the collection vehicle. This system leads to unacceptably low collection efficiency and too much waste is left on the streets of Phnom Penh.

3.1.3. Disposal

Collected waste is transported to the only existing dumpsite at Stung Mean Chey (SMC) for disposal. The site has been generally called Stung Mean Chey dumpsite. The disposal method is open dumping. There is no reclamation plan. Waste is merely leveled by bulldozer in a disorderly manner.

The present dumpsite has been used since 1965. It is located in the southeast about 5 km from the city center (central market) and the area is about 6.8 ha, but waste has spread over a larger area possessed by the municipality. It is said that the dumpsite is already full, but because the municipality fund is not adequate to allocate resources for new landfill, collected waste has still been dumped there in spite of warnings about the very high level of pollution. The new landfill project is included in the PIP of the government. However, the project has failed to attract the attention of donors or investment banks.

3.2. Institutional arrangement system

There are some agencies, which are at least partially concerned with SWM in Phnom Penh city. This section reviews first the legal responsibilities of the agencies concerned and then their actual responsibilities in practice.

3.2.1. Responsibilities by law of the concerned agencies

3.2.1.1. *Ministry of Environment (MOE)*. The MOE was established in 1993. The environmental protection and natural resource management law clearly prescribes that the Ministry has responsibility for establishing proper guidelines for SWM and supervising its execution. The MOE is also responsible for monitoring and enforcing compliance with the environmental law and the operation and discharge permits. Therefore, the ministry has the responsibility for SWM at the national level.

3.2.1.2. *Ministry of Planning (MOP) and Ministry of Economy and Finance (MOEF)*. The MOP and the MOEF are involved in approval of sector investment plans, establishment and approval of cost recovery levels and appropriate service tariffs, allocation of government funds for investment projects, and solicitation and organization of grant and loan financing from international financial institutions and donors.

3.2.1.3. *Municipality of Phnom Penh (MPP)*. The sub-decree on solid waste management prescribes that the collection, transport, storage, recycling, minimizing

and dumping of waste in provinces and cities is the responsibility of the authorities of the provinces and city. Therefore, the MPP has the responsibility for SWM in the city.

3.2.1.4. Phnom Penh Waste Management (PPWM). MPP established two service organizations in February 2001, namely Cleansing Authority of Phnom Penh (CAP) and the Wastewater Authority of Phnom Penh (WAP). Both were established based on the government sub-decree of April 1999 regarding the government's public administrative financial policies. To reduce the administrative costs and increase operational efficiency, the MPP decided to merge the two organizations into one authority, Phnom Penh Waste Management (PPWM). It is described in a statute of PPWM that PPWM has the responsibility for the solid waste business in the city. According to its statutes, PPWM has very broad mandates; it may itself deliver SWM services, such as collection and disposal, or contract out these services, and monitor the performance of the service providers.

3.2.1.5. Private company. The solid waste service has been provided in Phnom Penh city by a private company. The contracted company has the sole right to collect and dispose of all municipal waste from within the city. The company is also requested to collect user fees from households, enterprises, institutions, etc., to recover its operational costs.

3.2.2. Responsibilities of the concerned agencies in practice

In the present SWM system, PPWM, which has a wide mandate in SWM to control the operation performance of the service provider (private company), is presently only responsible for the operation of its own disposal site, without any permit from the MOE. The MOE, which is responsible for monitoring and enforcing the environmental law, seems unable to perform completely its task, although it admits that the operation at the disposal site by PPWM is neither technically nor environmentally acceptable.

3.3. Existing financial arrangement system

The MPP does not have adequate financial resources to operate its own collection and disposal systems. It has solved this cash flow problem by franchising out the SWM services to the private company, which can recover its cost from the people who benefit from the service. In this way, the solid waste service can be offered in the city but the service quality control has not been fully implemented because the MPP has yet to insure financial resources for monitoring the performance of the service provider. It should be noted that the MPP created

the PPWM but has not allocated any funds to the body for operation. The revenue of PPWM is mainly from the disposal fees levied on the private company, with a small part from grants from international donors.

4. Evaluating the existing SWM system

In Cambodia, there are some areas in the city where residents are considered squatters. The SWM in these urban poor areas requires an appropriate management strategy that may be different from that for the central urban areas (Kum et al., 2004). This paper is focused only on how to improve the SWM system in central urban areas of the city.

4.1. Evaluating the technical arrangement system

4.1.1. Waste storage

At residential areas, because of an unavailable storage system, waste is placed in plastic bags and left along the curbside for collection. The waste is scattered by scavengers. According to Flintoff (1984), the cost of removing waste which has been scattered in the streets is much higher than the cost of collecting similar waste which has been placed in containers such as domestic waste bins or litter containers. At the commercial and institutional areas, waste is normally placed in large non-standard bins provided by the individual owners. The transfer of waste from the large bins and containers to the collection vehicles is done manually. The process is time-consuming and results in much littering. Although the crew attempts to sweep up the waste, there is a limit to how much time they can spend on this. At the places where the waste needs to be collected daily, or even more frequently, such as food markets, communal collection points, etc., the storage bins are not adequate enough. It is common to see the market waste dumped on the ground in free space near the market and these places become collection points. This practice is technically unacceptable. However, it is still seen continuing in the city. Thus, the lack of a workable storage system at the source of waste generation is considered the most serious shortcoming to the present waste situation in Phnom Penh. An appropriate storage system should be established and introduced. The non-standard individual bins of the owners of the restaurants, hotels and institutions should be replaced with standard bins or containers. This system may need trucks with special loading equipment because the larger standard bins are too heavy to be manually loaded into the trucks. Such a system will increase the investment cost, but may result in operating cost savings as the loading will be much faster and the productivity of the collection equipment and crew will be higher. When the appropriate storage system is introduced, the private

company will need to establish a proper plan for collection according to the volume of bins provided to avoid the spillage of generated waste.

It is also worth noting that while a standard container system is probably significant to improve collection productivity, it also faces some problems to be solved. The fact is that containers for waste storage may be stolen and used for other purposes. This happens in many developing countries (Cointreau, 1982; Flintoff, 1984; Ogawa, 1989). But, the problem may be solved by labeling each container, or by fixing the containers to a post or metal chain, or in any way making the bins easily recognizable as bins for waste storage and not for other purposes. However, without an appropriate storage system, most people still continue their practice of putting waste in plastic bags along the curbside for collection. This will require fixed collection schedules and much more reliable collection timing than today. Therefore, an appropriate storage system can be considered also as a way to facilitate the collection operation and it should be introduced into the waste management system in the city.

4.1.2. Waste collection and transportation

Collection efficiency in the central urban areas under the present operating system is low. The low efficiency may be because the collection crew spends so much time in collecting the loose waste that is normally dumped on the ground or scattered around the scarce rubbish bins, which is due to the lack of an appropriate standard of storage system, and/or because the number of the vehicles used is not adequate for the operation (Mori, 2000).

According to Bhat (1996), the collection and transfer cost normally takes from 70% to 80% of the total budget for solid waste management. Because solid waste collection is a very costly service and the most expensive phase of waste management, the poor technical arrangement of the waste collection system practiced by the private company in the city may lead to a high operation cost. As a result, the private company may try to increase the cost of collection fees to recover the operation cost, but this may not be possible because the per capita income of the general public is still low. As a result, the private company may perform its service according to the resources available that it can manage from the collection fee, and the collection service will deteriorate. As mentioned earlier, PPWM cannot do its job well, monitoring the service performance offered by a private contractor that is in a monopoly situation, especially when the contract with the private contractor lacks specifications with respect to service level and standards. As a result, there may be a potential threat from the uncollected waste to urban environmental degradation in general. Therefore, the existing collection system should be replaced with a more efficient, but not more expensive system.

Waste scattered from the collection trucks during transportation may be due to the lack of appropriate cover during the trip. It is a normal requirement that the waste should be covered during transport and this is imperative for motor vehicles traveling at 30 km/h or more (Flintoff, 1984). So, the waste collection crew should carefully cover the waste during the transportation. However, the use of compactor trucks for the transportation of waste as a means of enclosing waste during transport, may not be an appropriate solution. A compaction vehicle is specifically designed for the waste volume reduction. In developed countries, the compacted density of municipal solid waste is about 400–500 kg/m³ from the initial density of 100–150 kg/m³ (Flintoff, 1984). The non-compacted (initial) waste density in Phnom Penh city is already in the range of 350–400 kg/m³ (Table 4). This means that the benefit from compaction would not be significant. Moreover, the use of compactor trucks requires high investment and operating cost and also complex additional maintenance. It should also be noted that compaction of mixed and wet waste that is typical in Phnom Penh city tends to force out the moisture and discharge it as a leachate. As a result, using compactor trucks to solve the scattering of waste during transport is not an appropriate alternative.

4.1.3. Waste disposal

Because the MPP has very limited financial resources, uncontrolled dumping may be the only option available at the moment because it is the cheapest type of land disposal. However, it should be noted that such a practice puts the public and the environment at risk from underground and surface water contamination, toxic smoke and waste blown by the wind, vectors, etc. Such a practice should not continue because it is not environmentally acceptable, and it makes the useful life of a disposal site even shorter. The economic reason for taking care that disposal sites have the longest possible life is that, once these sites are filled new ones usually can be found only at a greater distance and this increases transportation cost considerably, which accounts for the major share of overall cost (Komorowsky, 1983). Still, an effective strategy to make the disposal sites have the longest possible life should focus not only on technical operation at the site, but also on waste diversion that will include source reduction, recycling, and waste transformation through composting. Unfortunately, the waste management system in Phnom Penh city has not included any strategy to divert the waste from entering the dumpsite. Though recycling and composting can theoretically divert a certain amount of waste from disposal, their chance of success in practice in Phnom Penh city is limited (Kum et al., 2004). So, “prevention is better than cure” may be a good idea in managing the solid waste system. This means that with the same objective to

minimize the pollution from solid waste, it is better trying to *prevent* the waste at source of generation through source reduction than just trying to *cure* the generated waste through waste treatment/transformation.

Regarding waste disposal by incineration, the municipality should not enter such a scheme because the system may not be economical or sustainable to be applied in the city of Phnom Penh. Without conducting a detailed economic analysis, the waste characteristics in the city already shows an important indicator. According to Rhyner and colleagues (1995) “fuel with a high heat value (greater than 5000 kJ/kg), low moisture content (less than 50%) and low ash content (less than 60%) can be burned without additional fuel”. The waste characteristics in the city (Table 4), do not meet the specification. Therefore, the MPP should leave this issue to promoters from the private sector to finance, build and operate such plants. If the promoters feel that this system is truly financially sustainable in the country, they should be willing to develop and operate it without subsidies from the Municipality.

4.2. Evaluating the institutional arrangement system

It generally proves to be politically and practically difficult for a regulatory governmental unit to enforce compliance with regulations, which were violated or ignored by other governmental units. Therefore, the MOE would find it difficult to monitor the disposal site management operated by PPWM and it may be difficult/impossible for the MOE to collect fines from PPWM for any violation of regulations.

Also, during the data collection, it was found that the information seems really “*secret*”. Data that is available at the PPWM department is not available at the MOE and vice versa. There seems to be a lack of coordination among the relevant waste agencies. This is seen to be one of the major shortfalls in the institutional arrangement system and may lead to the duplication of efforts on the same project because a local waste authority is not aware of what others are doing. This is always a waste of resources and time.

Another important factor that should not be overlooked is the lack of human resources in the PPWM department. According to Mori (2000), there are just a few persons in the PPWM department who empirically have an understanding of waste management, and only one person who learned the SWM systematically through the training course held by JICA in Japan. This shows that human resources in this field are still very low and more training is needed. Though such a problem is commonly found in developing countries due to the low priority given to the waste management sector (Ogawa, 1989), it proves to be a major obstacle to effective waste management. This is based on the fact that developing countries usually seek external aid packages

from donor countries, usually developed countries, to build a Master Plan for almost any project. Only urban SWM case is cited as an example herein. In this case, the consultants are often from the donor countries. The consultants from developed countries sometimes have no background in urban SWM in developing countries and try to promote highly mechanized systems that are successfully applied in developed countries but not in developing countries. This happened in Tanzania. In the Dares Salaam Master Plan (1979), an action program written by the professional who had developed the Master Plan wrote: “Compactor lorries should continue to replace side loaders for the roadside collection. The refuse can be compacted to a density of approximately at 350 kg/m³ thereby giving a lorry capacity in order of 5,250 kg.” (Yhdego, 1988). According to Yhdego (1988), many solid wastes in Tanzania already have an initial density similar to that of compacted waste. This means that the justification in the Master Plan for compaction equipment on the refuse collection vehicle is not reasonable. Such a mistake should not be repeated in Cambodia. But, how can this be avoided? Without adequate competent local human resources in the SWM field, such a problem may be easily repeated in Cambodia. Therefore, human resource development with technical expertise in this field is really needed and should be timely.

4.3. Evaluating the financial arrangement system

Taking into account, the fact that the MPP’s financial situation is difficult and the fact that the government’s development objectives have prioritized public spending on agricultural and rural development (MOP, 2002b), private sector participation in SWM may be the only realistic alternative to solve the cash flow problem of the MPP. This is based on the fact that, though the SWM project may be considered to have a high priority by the MPP, the project does not fall within the prioritized national development projects and, therefore, it may be difficult to be approved by the central governmental units.

Borrowing money from a development bank may be another alternative, but that, too, is not promising. This is because the preparation of projects to be supported by international development banks will need to follow rather strict and lengthy procedures and requirements (Cointreau, 1982). The tough conditions imposed by the banks may not suit the municipality.

Although private sector participation is viewed as one way to secure investment finance from private companies for solid waste equipment and facilities in return for contracts to provide service, it is very unlikely that the most cost-effective services have been achieved since the contracting was done without competition at the bidding stage. It is believed that better service may be

obtained for the same cost if a competitive bidding process is combined with a service agreement that includes a clear and monitorable service standard. Moreover, the MPP created PPWM but has not allocated any budget to the body to perform its task. The budget for sustaining the body is partly from revenue from disposal fees for the disposal site maintenance allocated by the private corporation, and some small amount from international donors. It should be noted that donor agencies have their own upper limits to financial support and not all donors are interested in the SWM sector. As a result, there is a limited amount of funds to be allocated to the sector (Ogawa, 1989). So, the financial arrangement of the PPWM should be reviewed to better reflect the long-term objective, taking into account PPWM's statute according to which it has a broad mandate and very important role to play in the SWM sector.

The MPP should allocate enough funds for PPWM to perform its tasks, but the promotion of PPWM to be a self-financed institution should be based on a detailed study. This is because the solid waste service may be different from water supply or electricity supply services. Former governmental units in the public sectors, such as Phnom Penh Water Supply Authority (PPWSA) and Electricité du Cambodge (EDC) have developed themselves to be autonomous and self-financed authorities with a remarkable success. However, the strategy might not be promising for the case of solid waste service because the general public still has a low environmental awareness and a low income per capita. Therefore, the willingness to pay the collection service fees may not be as high as to pay the water and electricity fees.

4.4. Public participation

Although the technical, institutional, and financial arrangements of the existing SWM system need improving, public participation is also important and should not be overlooked.

In Phnom Penh city, it is common to see people throw litter from cars or motor vehicles into streets while traveling and to see people in the parks leave litter on the park benches even though rubbish bins are situated within walking distance. This is really a lack of responsibility of being a citizen and has a negative impact on the cleanliness of the city in general. In more serious cases, in some areas in the city, people deliberately dump their waste into open manholes or drains thinking that it will be carried away with the rainwater, not understanding the clogging and pollution problem this causes. Sometimes, they burn their excess waste in the streets, creating health risks and environmental problems. In other areas, especially medium or higher income areas, the situation is better. People do not burn their household waste, but leave their plastic bags of waste along the streets where the waste becomes scattered by scavengers. The private company al-

ways complains about this. According to the operation manager of the private company about why there is still so much waste along the streets in the city, the answer is that the general public does not understand and respect the waste collection schedule of the company and that there is a lack of co-operation from the public to make the city clean. But, the question is whether people are well-informed about the waste collection schedule. Is the waste collection schedule fixed? Are there enough storage bins so that people can dump their waste? If not, where can the public put their garbage – on their premises and wait for the irregularly scheduled waste collection? Does the private company really understand this?

However, activities of urbanites such as throwing the waste into the streets, dumping it into open drains or burning it in the streets are the responsibility of the general public. This also shows that the general public has not been motivated to participate actively in waste management issues. So, there is a need for a greater public participation in lobbying for better SWM in Phnom Penh city. The increased public participation may be carried out by means of all sources of media, such as television and radio networks, as well as newspapers, to increase the public awareness. However, for the long-term objective, such a strategy may not be enough. The environmental issues, including the solid waste issue, should be included in the school curriculum to build human resources for future generations.

5. Conclusions and recommendations

It can be inferred that solid waste management has interwoven and interdependent issues. The issues should be addressed from a system perspective by taking into account the technological, financial, institutional, legal, and socio-cultural factors to determine appropriate policies for the local surroundings. It can also be inferred that although private sector participation in solid waste management is seen as a way to solve the financial constraints and offer the solid waste service to meet the demand of the public in Phnom Penh city, the lack of competent professional staff and adequately designated authority of the local waste authorities are major obstacles to develop, negotiate, manage, monitor, and enforce a sound contract instrument.

The recommendations below are based on the discussions as presented in previous sections:

- Appropriate storage systems at the sources of waste generation should be introduced into the waste management system in the city.
- The capacity of the local waste authorities should be improved and enforced by establishing a human resource development program so that they can have a better control of the SWM system in the city.

- Information sharing among relevant waste agencies in SWM should be much wider to avoid duplication of efforts for SWM projects in the city.
- The role and responsibility of PPWM should be reviewed and clarified as to whether PPWM is a supervising agency or an executing agency in SWM in the city.
- The MPP should allocate an adequate budget for PPWM so that PPWM can better perform its task, controlling the performance of the provided service in the city.
- Regulations regarding littering and improper disposal of solid waste should be formulated, and penalties should be imposed on violators.
- Public awareness about the environment should be increased through environmental education and training program so that the public participation in SWM will be increased.
- A source reduction program should be initiated and strongly promoted because it is a way to address waste prevention and the diversion of materials from the waste stream, and this could contribute to a sustainable SWM objective.

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