Cost Analysis of Solid Waste Management System for the City of Lake Bhopal

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Abstract: **Solid Waste Management (SWM) is of great concern for municipalities in the Bhopal especially after the transpired environmental problems of the low cost malpractices related to the existing dumps that pollute the environment. Cost studies have played an important role in evaluating waste disposal methods and advocating one option over another. This paper aims at quantifying the benefits and costs of the solid waste management options in Bhopal City in order to help future policy decisions, evaluating the existing SWM system and estimating the least cost option for managing solid waste in the City.**

Keywords: Solid waste disposal, public private partnership, cost analysis

I INTRODUCTION

India, being a developing country, is under rapid development process with a Gross Domestic Product growth rate of 9.4 % in the year 2006-2007. The Indian economy is amongst a few fastest growing economies in the World. However, wealth distribution in India is fairly uneven, Top ten percentages contribute 33 % of total income and India stands 27th as per UN Gini Index for income inequality metrics, In India 28 % population lives in urban area and there are 109 big cities and 3574 Small & Medium Towns. The country is loading forward to achieve the Millennium Development Goals (MDG).One of the targets of MDG is to halve the proportion of population without sustainable access to safe disposed of waste by 2015. Yet the problem of the level of service and coverage in new areas of towns remains to be tackled. This is due to the entirely different scenarios in big cities and small towns of the country. Big cities in India having the privilege of multiple opportunities could raise capital for investment of Schemes Waste Disposal Schemes (WDS) without waste disposed much difficulty and could arrange for technical expertise from a consultant or by their own. However, it has been observed that Local Bodies in Small & Medium Towns are often unable to raise sufficient revenues to manage the existing systems; and therefore do not become financially independent with the levied water tariffs. Therefore, planning, implementation and operation of waste disposal systems in small and medium towns demand special attention. The poor maintenance of a WDS results in a low satisfaction level of the consumers and therefore low recovery. To ensure full cost recovery the tariff structure needs to be reviewed periodically.

In India, waste utility works on monopoly pricing and no Regulators are yet established at Central or State level to regulate disposed waste prices. The local bodies are the sole regulators and decide their waste rates under politically influenced system, which results in insufficient revenue to cover its Operation and Maintenance cost. PPP cannot sustain under such condition, as private partner would have monetary losses. On the other hand, it is also necessary to assure that private partner is providing satisfactory services and not imposing unjustified tariff. This paper addresses to the development of a computer-based tool that takes into account variable costs which include actual expenses to be incurred towards parameters like manpower, energy, chemicals, raw water charges and fixed cost like repayment of investment made to arrive at the actual cost of operation and maintenance. The model also includes a reasonable profit to private partner and takes care of the increase in demand as population increases and incremental cost required to meet it throughout the PPP arrangement. The model can be used t calculate the actual cost due to variation in

charges towards manpower, electricity, chemicals and raw water charges.

II REVIEW OF PERTINENT RESEARCH

For effective designing and recovery of tariff, which is likely to be increased due to additional infrastructure, one has to ascertain the economic value of waste. It is defined as the amount that a rational user of a publicly or privately provided waste resource is willing to pay (ward 2007).

As long as the public can be made to pay the true cost of a municipal service, either a private entity or a public entity can be efficient producer of the service (Jones et al., 2004). In both cases a sound regulatory framework is essential for whoever ultimately provides the municipal service and is not limited to just the private entity. The stakeholder input and a transparent process is crucial in deciding when and what to privatize. However, once the decision is taken that a certain service is essential, provisions should ensure that all citizens have affordable access to such services. Such access does not necessarily limit the use of privatization; however, it requires a suitable design of the PPP model.

The waste tariff is generally fixed based on the marginal or incremental cost. Chambouleyron (2003) suggested marginal cost pricing in which each water user pays a price that reflects the incremental cost of waste used. Marginal cost refers to one unit change while incremental cost usually refers to multi unit changes. Setting the price of waste equal to marginal cost means that each consumer pays a price equal to the incremental cost imposed on the system for providing service. Marginal cost pricing in not safe if not judiciously applied. Even the strongest supporter of marginal cost pricing realizes that it can be politically dangerous. Careless implementation of marginal cost pricing risks pricing a basic human need so expensive, that poor people cannot afford their waste disposal without shouldering a politically unacceptable burden.

Mann and Schlenger (1982) suggested that marginal cost and incremental cost are interchangeable for practical purposes. Mardsen et al. (2004) showed that the average incremental cost is easy to understand and calculate as compared to marginal incremental cost. Beecher and Shanghan (2008) suggested monitoring the cost and revenue periodically and to make needed adjustments to bridge the gap between theoretical and actual results for long term sustainability of waste disposal projects. Equity and affordability are also valid considerations in utility management and rate making. Mann (1993) suggested the regulatory arrangement to offer both public and privately owned waste utilities, and greater incentives to develop more efficient waste disposed practices.

III COST ANALYSIS

Cost analysis is an important tool in decision making. The idea is to evaluate all the costs of a proposed policy or action, in order to determine the least cost option. The net benefits can also be determined by subtracting the total costs from the total benefits. The basic goal of this process is to determine which decision maximizes the possible benefits of a policy or action (Jackson and Strauss, 2007).

Conducting a cost analysis has many elements such as calculating the operating costs of all options. However, it also contains elements that are harder to quantify such as the environmental effects. These effects, which are not directly imposed on the operators, are considered external factors. External factors (that is, externalities) can either be negative or positive. When attempting to conduct a cost analysis externalities must be included, since someone in the community does eventually bear the external costs and benefits of them. The analysis also should consider the various external costs associated with each option. The negative externalities associated with landfills include environmental effects to the surrounding area. The environmental effects arise from the greenhouse gasses (such as methane) emitted from landfills when waste decomposes, the potential groundwater pollution through toxic seepage, and air pollution from the transportation of waste. The local externalities include decreased property

values in the areas surrounding landfills, increased traffic, and increased traffic accidents (Jackson and Strauss, 2007).

A. Cost Estimate Consideration

For estimating the cost of MSW management system, the full cost accounting (FCA) procedure which is derived from the Municipal Solid Waste Management Full Cost Accounting Workbook for Local Governments, is to be used. The FCA is a tool that helps to assess and report accurately and consistently the full costs of managing MSW. Because FCA offers a systematic approach for determining the full costs of MSW services, managers can identify accurately the cost of different MSW program options and contemplate adjustments to current levels of service FCA data can be used to help establish rates and user fees that are sufficient to recover the full costs of the MSW services provided.

FCA is a systematic method of identifying, summing, and reporting the costs incurred in providing solid waste management services to communities. In addition to the obvious and direct costs of MSW management, FCA includes both "overhead" and "hidden" costs incurred to provide necessary support services for solid waste programs.

In implementing the FCA we focuse on all aspects of MSW management, identify all activities to be considered, clarify which costs are to be included, buildings, equipment, and properties used in MSW activities, identify human resources involved in the MSW management process, avoid double counting, include appropriate shares of indirect costs for activities that support MSW management and provides detailed cost information in a simple, concise format (FCA, 1997).

The following activities, in general, are considered in estimating the total cost for solid waste management options:

1. SW collection activities
2. Transporting activities
3. Indirect operating cost
4. Landfill activities
5. Recycling activities
6. Transferring
7. Compost activities
8. Pre developed and construction
9. Closure and post closure

Three basic steps to calculate accurately the full cost of MSW services and programs are summarized in the following:

1. Identify all direct costs associated with providing MSW services
2. Identify all indirect costs associated with providing MSW services
3. Using financial records, and assign directly or allocate the costs of MSW management (identified in Steps 1 and 2 above) to the various solid waste programs (for example, collection, recycling, and disposal program areas).

The calculations include estimates for the items listed in the following sections.

B. Wages and benefits

Wages and related benefits include the following:

- Total annual wages
- Total annual benefits (insurance, holydays). Noting that these benefits are considered additional cost for the Municipality budget.
- Total annual post employment benefits

C. Depreciation of capital outlays

The established accounting technique of “depreciation” can be used to convert capital outlays into annual costs. Depreciation is a method of allocating the costs of capital outlays over the useful life of the resource, which is the period of time during which the resource is expected to provide services adequately and efficiently.

D. Amortization of future outlays

A “future outlay” is an expenditure of cash in the future that is obligated by current or prior activities. For example, the obligation to perform

closure and long-term care is triggered when landfill operations begin. In addition, post employment employee benefits, such as payments for health care or retirement can be considered as a future outlay.

E. Indirect costs

Indirect costs represent the costs of essential services provided to the MSW program by other departments of the Municipality, as well as costs incurred by other departments for general administration and executive oversight.

The method of allocating indirect costs requires that the Municipality first calculate the ratio of its MSW employees to its total employees. Second, the Municipality has to list the total budgets for each individual, group, or department that provides support services to the MSW program. The total budget for each individual, group, or department is then multiplied by the ratio of MSW employees to total employees.

F. Benefits

It is important to consider all the proposed benefits associated with each MSWM option. Air and groundwater protection, reducing transportation of waste, reducing the local property devaluation, reducing health risks caused by air and water pollution, recycling benefits, job creation, resold of compost and recyclables materials, all of these benefits are to be measured and compared for each MSWM option.

G. Estimating the external costs of landfill

The various external costs associated with landfill operations are to be considered in the estimations. Some of the most widely recognized and largest external costs associated with landfills are air and groundwater pollution, transportation of waste, local property devaluation.

Another relevant issue is scarcity rent, which is a function of the variable costs of operating plus a component of the cost of opening a new landfill and closing the previous one. In this way, the price of landfill disposal increases as the resource becomes increasingly scarce. The amount of scarcity rent added to the variable cost of operating the landfill will be very low when the resource – that is, the landfill – is plentiful, but increasingly becomes a factor as the resource is reaches exhaustion (Jackson and Strauss, 2007).

In the absence of a related study for finding the value of scarcity rent for the existing landfill in Bhopal City it is very difficult to include this value in our stimations, noting that it is important to consider this issue in our solid waste management in the city.

H. SW collection and transporting activities

In this section, the costs of collecting and transporting MSW for Bhopal City are estimated. In collecting and transporting the MSW for Bhopal City, the following items were considered:

1. Labor wages (including the wages of the street cleaning groups)
2. O&M cost of SW collecting trucks (including fuel cost)
3. Collecting and transporting vehicles drivers wages
4. Operating cost

I. Indirect operating costs

Indirect costs represent the costs of essential services provided to the MSW program by other departments of the Municipality, as well as costs incurred by other departments for general administration and executive oversight. These departments are the Administration Department including the Mayor office and the Municipality Council, the Accounting Department, Municipality warehouse and Computer Programming Unit.

J. MSWM Benefits

Direct economic benefits from the solid waste management program (SWMP) consisted of revenues from non-fee and fee-based sources and the value of avoided landfill costs due to solid waste diversion. The revenues encompassed the earnings of the Municipality and the earnings of other parties including waste pickers (for example,

from selling recyclables). Avoided landfill costs are estimated by multiplying the overall amount of waste diverted by the cost of the operation and maintenance of landfill per unit of waste (DHV Netherlands and PHG Palestine, 2008)

In Bhopal City there is no recycling program. Recycling activities are carried out by waste pickers at small scales. They pick metals and sell it to local contractors it is worth to make an investigation or a study to quantify the volume of recycling operation in the city. (HED, 2009).

K. Transferring MSW cost

One of the options for the disposal of MSW in Bhopal City is constructing a transfer station and transport MSW to Adampur Sanitary Landfill in Raisen District. When the solid waste disposal unit is remote from the collection area, a transfer station is to be built and used. In the transfer station, waste is collected from smaller collection vehicles to larger transfer vehicles such as trailers and tractors. Transfer stations can be quite simple or they can be complex facilities.

L. Closure and post closure cost for the existing SW landfill in Bhopal City

When the existing solid waste landfill in Bhopal City reaches its capacity, it is important to perform closure and post closure program to prevent the infiltration of rainwater into the waste body which will lead to the formation of leachate and may pollute the groundwater aquifers, as well as to avoid the spread of waste to the surrounding area. The final waste body has to be covered by a surface sealing system.

M. Local property devaluation

Due to the presence of the existing SW landfill, the surrounding agricultural lands lost part of its selling value. According to Bhopal Municipality the affected areas are estimated to be about 98,000 m^2. This area is affected directly but the area that is affected indirectly is more than that. Also it is important to know that the devaluation of the local property in the landfill surrounding areas is to be more and more as the selling value of the lands in Bhopal city becoming higher and higher due to the limitedavailable lands in the city. If the owners of the surrounding lands are to be compensated the compensation amounts is proposed to be the yearly benefit of the land's value.

III CONCLUSION AND RECOMMENDATION

1. Bhopal Municipality is encouraged to have a specific project for the proper closure and post closure of the existing solid waste landfill. This project will eliminate the local property devaluation at the landfill area and protect the groundwater. About 22 thousands meter square of land is to be available for the municipality to be used for other purposes after the proper closure of the existing solid waste landfill.
2. It is recommended that Bhopal Municipality starts to have pilot programs for solid waste separation and recycling in addition to the generation of compost especially that the city is located in an agricultural area. This will reduce the cost of solid waste management by reducing the amount of land filled waste and improves the environmental conditions in the city.
3. Bhopal Municipality is encouraged to study SWM options carefully, choosing the most economical and environmental option which will decrease annual expenses for SWMS and provide additional funds to construct vital projects in the City.

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