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Economic Feasibility of Household Waste Minimisation in Dhaka, Bangladesh

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Abstract

This article examines the economic viability of waste minimization through reuse and recycling in the city of Dhaka, Bangladesh. To achieve the objective of the study, this document carries out the cost-benefit analysis (CBA). The cost-benefit ratio (BCR) of waste minimization is 1.23 which reveals that waste minimization is economically justified and capable of generating. This study shows that minimization of solid waste in the city of Dhaka is not only a social or environmental imperious, an economically feasible mitigation and, therefore, can be a good alternate to conventional options for solid waste management, reducing the amount of waste transported to and unloaded and recovering valuable materials.

Keywords: Waste generation, waste composition, waste materials recycling, benefit-cost analysis

1. INTRODUCTION

Urban solid waste management is believed to be one of the most severe environmental problems facing urban areas in developing countries (Pfammatter and Schertenleib, 1996; Sinha and Enayetullah, 2000; WRI et al., 1996) and the urban center of Dhaka in Bangladesh is not an exclusion. Dhaka city, with more than 10 million inhabitants, is one of the fastest growing mega cities in the globe. In the period of 1991 to 2004, it has an average yearly growth pace of population more than 4 percent (DOE, 2004). Finding adequate waste disposal sites for the hereafter is likewise very difficult at this moment with the increased in population and horizontal expansion of the urban center. Overall the city corporations have failed to handle the whole waste of this increasing population, primarily because of deficiency of fiscal documentation and willingness to pay (WTP) and low participation of the households for overall sustainable solid waste management policies. Thus, in that respect is a desperate need to determine the waste minimization options to resolve the current troubles. Granting to the Urban Local Body Ordinance of 1977, the Dhaka City Corporation (DCC) is responsible for the collection, conveyance, and treatment of solid waste. Nevertheless, the current waste management system in Dhaka has generally neglected to address a broad range of waste disposal problems through inefficient, corrupt, centralized and politicized management. The site gets more chaotic due to inadequate financial resources; the low priority of solid waste management and the territorial expansion and rapid growth of the urban population (Banu, 2000; Asaduzzaman and Hye, 1998; Kazi, 1998). In Dhaka, solid waste generation amounts to 3500 miles/day, of which 1800 tons are collected and dumped by the DCC, 900 tons end up in backyards and informal landfills, 400 tons end up along roadsides or open space, 300 tons are recycled by the Turkish (destitute slum children acting as scavengers), and 100 tons go through informal recycling at the stage of generation (DCC, 2007). Although the DCC collects about 50% of the solid waste, it has no sanitary landfill for its ultimate disposal. Only a small percentage of solid waste collected is dumped at the only landfill site at Matuail. A major portion is dumped in the low –lying fields in and

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around Dhaka city. Solid waste is believed to be a substantial source of pollution, health hazards, and environmental degradation, including localized flooding through clogging of drains and Canals (Tawhid, 2004). This presents a significant problem in a city where 30% of the population lives in slums and only 22% of these has access to municipal waste collection bins (GoB-ADB, 1996).

DCC was going wrong to furnish the proper resolution to these basic problems connected to solid waste management. This office has put forward the evolution of some community-established organizations (CBOs) as they can fulfill this gap (Banu, 2000). As a result, solid waste collection services improved significantly, but health hazards and greater environmental problems remain unchanged. CBOs provide a door-to-door waste collection for a monthly lump sum (normally between TK [1]10 to TK 25). This furnishes a service for waste collection to residents' doorsteps, but waste disposal and management at community dustbins and landfill areas remain unchanged (Banu, 2000). The CBOs' operations lack public support and corporation (Banu, 200). Neither the DCC nor the CBOs consider waste minimization and resource recovery an alternative choice and consequently, key problems of one of the world's most thickly populated cities remain unresolved. The economic, social and environmental benefits from waste minimization and recycling are enormous (Begum et al., 2006; Massoud et al., 2003; SKM, 2003) and they have gone forth as the preferred methods of solid waste management in many countries (Aye and Widjaya, 2006). Nevertheless, in the DCC's approach, the concepts of resource recovery, minimization, and recycling are missing. Likewise, the CBOs' initiatives concentrate on the house-to-house collection of waste, only the concept of the 4R's (reduce, reuse, recycle and recover) is absent (Sinha, 2001).Household waste in Bangladesh is the second largest fraction of municipal solid waste (DCC, 2005). Handling the organic fraction of waste from household on a business scale may be more attractive than handling the other waste since the wastes from household have high organic contents and is a more concentrated source. The case studies conducted in Bangladesh demonstrates that waste minimization (three R's; reduce, reuse and recycling) is economically feasible and also plays an important role for the improvement of environmental management. Thus, waste minimization of household waste materials needs to be encouraged and furthered in the community because it is one of the most significant wastes generated in Bangladesh in terms of intensity. Nevertheless, source separation should be implemented progressively in the hereafter. Without source separation, more waste goes to the landfill and more space is needed.

In late years, reuse and recycling of waste have been elevated in order to cut waste and protect the surroundings. The economic and environmental benefits to be gained from waste minimization and recycling are enormous (Guthrie *et al.,* 1999). The economic benefits of waste minimization and recycling include the possibilities of selling specific waste materials and the removal from the site of other wastes at no charge or reduced cost, with a subsequent decrease in materials going to landfill at a higher cost (Snook et al., 1995). Thus, it can increase households' awareness about their waste. By and large, economic feasibility is carried out employing the standard criteria of profitability such as cost-benefit analysis. Most studies revealed that there are many benefits associated with a waste minimization i.e. environmental, economic, financial obligation, public image, etc. (lotion et al. 1988; EH&S 1994; US EPA 2002.). According to the U. S. EPA (2002), waste minimization makes good economic and business sense and at the same time, waste minimization can improve output efficiency, profits, good neighbor image, employee participation, product quality and environmental performance. Dane et al., (2007) has also launched that there is a potential to increase rates of recycling at a positive net benefit for all waste streams. Hajkowicz et al., (2005) estimate the monetary value of waste relates pollution to Palau as 1.6% of gross domestic product and annual costs per household as US$0. 51. ACG (2003) found positive net economic benefits for zero waste strategy by cutting down the amount of waste and increasing the pace of recovery in Victoria, Australia. Using a cost-benefit analysis (CBA) framework, Kumar et al., 2004 estimated a delivery of around Rs 0.09 billion per annum of landfill gas recovery compared to the conventional landfill disposal in India. Begum et al., 2006 applied the CBA to estimate the economic feasibility of construction waste minimization in Malaysia. They constitute a net benefit of RM0.86 million from waste minimization. ACC (1996) found home composting an economically viable choice in US urban centers. Existing professional economic literature on solid waste management is basically focused on three issues as i) the applicability and viability of user charges in solid waste management, ii) analysis of which are the best tools to alter the percentage of packaging in the waste stream and iii) the benefits and costs of using those instruments to foster waste reduction and recycling (Schall, 1992; Repetto *et al.,* 1992; Skumatz, 1993; Brisson, 1993; Dinan, 1991; Pearce and Turner, 1993). Goddard (1995) pointed out that empirical knowledge is very suggestive on the first of these, sketchy on the second and virtually nonexistent on the tertiary. In that location is also advocacy literature on both positions of the various solid waste management options, recycling, being the current focal point of attention, that relies on limited or no economic analysis (Denison and Ruston, 1990; Schall, 1992.). Most studies focus either on the economic benefits of reuse/or recycling of waste (Alamgir and Ahsan, 2007; Dane *et al.,* 2007; Begum *et al.,* 2006; ACG 2003; Leu and Lin,

[1] US$1 = TK68.00(as in December 2008)

1998). None of these studies emphasized waste minimization and resource recovery as an integrated plan of attack. The mixed approach in this study designed to attain the following sequential goals (5R's):

- Reduce
- Reuse
- Recycle
- Recover waste transformation through composting and
- Residual's safe and filling.

An economic analysis would enable policy makers to decide an appropriate value for such intervention and help them identify whether such an advance of resource recovery is an efficient method of resource allocation. A financial CBA was previously taken for assessing the feasibility of the Waste Concern's pilot trial and found to be financially viable at the local level in Dhaka city (Zubrugg et al., 2005; Enayetullah and Sinha, 2001). Waste Concern is a Non-Government organization which is taking in waste from door to door from some residential areas of Dhaka city and doing the composting of organic fabrics. Yet, none of these studies include topics of economic efficiency of resource allocation, the indirect benefits of intervention strategy, or opportunity costs of resources. The aim of this paper is to examine the economic feasibility of waste minimisation such as reusing and recycling of household waste materials.

2. ECONOMIC ANALYSIS

Cost-benefit analysis (CBA) is widely used in assessing the allocation of resources to assess the social suitability of a particular minimisation. In this case, situations with and without minimisation (sometimes called a reference situation or status quo) should be clearly defined to identify the incremental cash flows arising from the minimisation. Resources will be allocated efficiently if the marginal benefit of the minimisation is greater than its marginal cost. CBA is a simple method when costs and benefits are properly identified, quantified and valued. The procedure for estimating the costs and benefits of the minimisation action is described in the following section. The CBA then summarizes the costs and benefits of the intervention at different times using a discount procedure.Thus a CBA can be expressed as follows:

$$NPV = \sum_{t=1}^{10} \frac{(B_t - C_t)}{(1+r)^t}$$

Where
NPV = net present value
B_t =Benefit of the minimisation
C_t = Cost of the minimisation
r = interest rate (i.e 10%)
t = time of the minimisation (i.e 10 years)

The total benefits are all the advantages of reusing and recycling of solid waste. This is the sum of willingness to pay off the respondents, revenue from the selling of recyclable materials, revenue from savings of greenhouse gas emission and cost savings of DCC. The total costs of the minimisation are all the prices associated with the waste collection, shipping, and administration. This is the sum of depreciated capital costs, operation and upkeep costs, composting costs, recycling prices and domain prices. The survey proved to quantify all benefits and monetary values in terms of monetary value and also those benefits and monetary values that do not receive a monetary value which is specified as an intangible term such as An (intangible benefits) and A (intangible costs). The benefit-cost analysis followed a conservative method of estimation as it is an initial survey. All the prices and benefits data were gathered from the Dhaka City Corporation (DCC). It is assumed that the duration of the minimisation is 10 years. The Ministry of Planning Bangladesh suggests to use a discount rate of 10% if a specific sectoral rate is absent (Alam, 2008). For this analysis, a 10% rate is used. Both costs and benefits are estimated at constant prices, ie, the taka amounts refer to the price values in 2008. The minimisation is acceptable if NPV> 0, otherwise it is rejected. Primary and secondary sources of information are used to achieve the study objectives. Secondary sources of information used are the information published by public agencies and private sector. Main sources of information include face-to-face interviews with different stakeholders including WC, Visits to the study area and direct observation.

3. RESULTS AND DISCUSSION

3.1 Total Benefits

The full value of willingness to pay (WTP) for improved waste management methods has been selected from the work conducted by Afroz R et al., 2009. The study has figured that the WTP of the respondents of Dhaka city is 13 Tk/ month (USD 0.18). The total number of households in DCC is 5,91,068. Thus, the aggregate value of WTP of the respondents in Dhaka city is (13 x 591068) or 7.6 million Taka/ month. So, for ten years, it will be TK 912 million. The revenue of selling of recyclable materials for scenario has been estimated in Tables 1 from local data gathered from DCC. It is estimated that in this minimisation, 91 million can be earned from selling of recyclable materials. Revenue from the selling of compost has been ascertained based on the current composting practices by Waste Concern. In this work, it has been taken for granted that all the constitutional portion of Dhaka's waste is treated in composting plants (a 100 percent composting rate), 66 percent (Enayetullah et al., 2005) of the total generated waste would be recycled using composting mechanism. With a waste generation of 3200 tons/day, the food waste of total waste amounts to 2112 tons /day. Splitting up this quantity by three to account for three-ton capacity composting plants, a sum of 704 composting plants would be required to process Dhaka's food waste. The production of three-ton capacity composting plant is 0.75 ton/day (Waste Concern, 2005). So, the production of 704 composting plants will be 528 tons/day. The monetary value of compost product is 2500TK/ton. Thus, the revenue from composting will be 481 million taka/year. For the 10 years, it will be 4810 million. The total benefits of whole waste management alternatives have been depicted in Table 2.

3.2 Total Costs

The entire monetary values are all the prices associated with the waste collection, shipping, and administration. This is the sum of depreciated capital costs, operation and upkeep costs, composting costs, recycling prices and domain prices. Total costs are made up of primary collection costs, secondary collection costs, final disposal costs, composting and recycling costs. Each price is comprised of depreciated capital costs and operation and sustenance costs. Depreciated capital costs for primary collection include the transport van and plastic containers, for secondary collection it includes the land price, building cost, container carrier box, open truck, and Handwheel Barrows and for disposals it includes land costs, development costs, chain Dozer, wheel dozer, pay loader, excavator. Operating costs include salary and fuel prices. For primary collection, the lifetime for collection van is assumed 5 years and for secondary collection, the lifetime for collection vehicle is assumed 10 years. Salary costs have been calculated on the basis of the daily wage of 90TK/day for street cleaner, truck staff and container stuff. In this subject, when fuel costs have been worked out, it has been assumed that 60 tons of waste are taken to the landfill per trip, the average length is 30 km each way and the fuel price is 45TK/liter. Total costs of solid waste management options have been shown in Table 3.

3.3 Economic Analysis

Once the costs and benefits are identified, quantified and valued, the next step is to assess the economic viability of the intervention action. This is done by comparing the costs and benefits (expressed in constant Taka terms) with and without the minimisation. The current net profit values for the minimisation over a 10-year period are presented in Table 4. The minimisation is expected to generate a net profit of Tk1120 million, with costs of Tk 4692.36 million and benefits of TK 5813 million over a period Of 10 years. Both the NPV and the cost-benefit ratio (BCR) are used to compare the monetary value of the total benefits derived in relation to the cost of the minimisation. The NPV of Tk 432.43 million is greater than zero, implying that the minimisation will generate a higher return than the minimisation. The BCR is 1.23, indicating that the minimisation is economically feasible. Therefore, it can be concluded that the minimisation is a viable alternative and has a net positive benefit and a higher BCR in relation to the status quo. It also includes some unmarked benefits (A ') such as saving space in landfills, reducing liability for environmental problems and safety at work, less likely to contaminate dirt and groundwater, better public image and environmental care. This unmarked benefit is also called a positive externality. Therefore, the survey also found that the reuse and recycling of household waste are economically viable in terms of price savings.

3.4 Sensitivity Analysis

A sensitivity analysis was completed to assess the effect of undefined variables on the outcome of the minimisation. It is essential since the uncertainty, the risk and the accurateness of the estimates for the minimisation. NPVs are calculated by means of different mixtures of worse and better case scenarios. These issues include (a) the effect of changing some key cost and benefit variables, such as estimates of the cost of capital and revenue; (b) the effect of the discount rate on cash flow. Six scenarios are developed based on the variation of the assumptions in Table 5. If these assumptions are varied, it is estimated that NPVs are as high as Tk 691 million or as low as Tk 208.35 million. Alternative scenarios include variable discount rates, increased capital costs, and decreased revenues. The sensitivity analysis shows that the minimisation is worth pursuing even with significant changes in the key variables. Although the variations chosen do not affect the viability of the minimisation, they slightly affect the size of the net benefits.

4. CONCLUSION

The aim of this study is to examine the economic viability of solid waste minimization through reuse and recycling in the city of Dhaka. This analysis provides an economic justification for making such public policy decisions by estimating the benefits and costs of minimization and reveals a BCR of 1.23 (ie> 1) which demonstrates that waste minimization is economically justified and is capable of generating. A net benefit throughout the life of minimization (positive NPV).This study demonstrates that solid waste minimisation in the city of Dhaka is not only a social or environmental imperative but is also an economically viable mitigation strategy and, therefore, it can be a good alternative to conventional solid waste management options, reducing the amount of waste being transported and discharged and recovering valuable materials. Not only can you save money on DCC's conservation budget, but the role of DCC can also be decentralized by restricting its responsibility for the safe disposal of waste from community rights and their deviation towards general control of the association agreement. It will be useful for resource allocation decisions to improve urban services in resource-poor developing countries. This approach not only shows a mechanism for establishing sustainable cities in developing countries but also demonstrates the ability to integrate the three main stakeholders into an effective and efficient framework. Its main strength is capacity building for urban environmental governance. The analysis provides valuable information for major mitigation measures to be undertaken to improve the well-being of society. It stresses the urgent need for concerted government intervention and, in general, involves all three stakeholders in the process, ie the government, the private sector, and the community.

5. POLICY IMPLICATIONS

By using fewer resources and scaling down the quantity of waste to landfills, the household's environmental concern will be raised in the community. In this aspect, economic instruments for minimizing household waste can be utilized to produce revenue for environmental policy, encourage prevention efforts, serve to discourage the least desirable disposal practices, as considerably as to avert the negative effects of environmental unfriendly treatment and disposal practices of household waste materials. For instance, the government can impose a subsidy for recycled household products, tax credit for the recycling companies that use recycled products, higher tax on the recycling companies that use virgin products to encourage reducing, reusing and recycling of waste materials and also to ameliorate the environment and waste management as well. Moreover, homes must be educated about potential cost savings from the waste minimization measures and the environmental impacts of the wasteland. The merits of waste minimization and environmental security must also be upgraded to the households and other guests. In line with this, DCC and other non-government organisation (NGO) can play an important part by distributing the data on the price savings of reused and recycled waste materials to the recycling companies, developers, and households. In conclusion, it can be proposed that waste minimization (three R's; reduce, reuse and recycling) of household waste materials needs to be encouraged and promoted in the households because it is one of the most significant wastes generated in Bangladesh in terms of intensity. The overall conclusion is that there is a need for government commitment and general interest of the public. The putting up of recycling industries will likewise relieve the state of affairs and at the same time create employment for the masses.

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Table. 1 Revenue from Selling of Recyclable Materials for 10 years

Materials	% of Total Waste	% of Recovered Material	Amount of Recyclables	Price (Taka/ton)	Revenue (In Taka)
Paper	10	5	5840	5000	292000000
Plastic	2.3	5	1343	4900	65816800
Glass	1.4	5	817	2100	17169600
Metal	0.9	5	525	7000	36792000
Others	17.3	5	10103	5000	505160000
Total					916938400

Note: Total solid waste generation is 1168000tons/year

Table 2. Estimation of the Total Benefits of Solid waste Minimization in Dhaka city for 10 years

Item of Benefits	Monetary Value of the Costs (Taka in Million)
Willingness to pay (WTP)for improved waste management system[1]	912
Sale of Recyclable Materials	91
Sale of Compost	4810
Intangible benefit (Non-health Benefits (A)): - Save landfill space; - Reduced liability which including for environmental problems; - Less chance of soil and ground water contamination; - Improved public image and environmental concern.	A
Total Benefits	5813+A

Note: 1. In this study, WTP value has been taken from the study Afroz *et al.*, 2009 and is considered as a health benefit. It is shown that most important sources of benefits are the sale of recyclable materials and sale of compost.

Table 3. Estimation of the Total Costs of Solid Waste Management minimisation in Dhaka City for 10 years

Item of Costs	Monetary Value of the Costs (Taka in Million)
Primary Collection a. Depreciated Capital Costs b. Operation Costs (Salary) c. Maintenance Costs	 60.36 40 20
Secondary Collection Costs a. Depreciated Capital Costs b. Operation Costs 1. Salary 2. Fuel c. Maintenance Costs	 1490 450 610 120
Final Disposal Costs a. Depreciated Capital Costs b. Operation Costs 1. Salary 2. Fuel c. Maintenance Costs	 460 30 60 50
Composting Costs a. Depreciated Capital Costs b. Operation Costs(salary)	 510 790
Recycling Costs(Salary)	2
Intangible Costs (A^*): - The cost of negative externality i.e. noising, bad smell.	A^*
Total Costs	$4692.36 + A^*$

[1]All prices and weights have taken in average.
[2]All prices and weights have taken in average.

Table 4. Cash Flow of Solid Waste minimization in Dhaka City

Description	Taka in Million
Total benefit	5813+ A
Total Costs	4692.36+A^*
Net Benefit	1120.64+ A'
NPV	432.43+A'
BCR	1.23

Note: It is assumed that $A > A^*$ so that there are some non-health benefits (A'). The argument is that in monetary value total benefits are more than total costs as well as in terms of the items, the non-health benefits are more than non-health costs.

Scenario	Description	NPV (million)
Scenario 1	Varying discount rate at 5%	691.35
Scenario 2	Varying discount rate at 8%	521.22
Scenario 3	Varying discount rate at 12%	361.49
Scenario 4	Increase of capital cost (primary +secondary+ final) by 10%	301
Scenario 5	Increase of capital cost (primary +secondary+ final) by 15%	236
Scenario 6	Decrease of revenue by 10%	208.35
Scenario 7	Decrease of revenue by 15%	211.84