Chapter

Economics of Solid Waste Management: A Review

Muniyandi Balasubramanian

Abstract

Solid Waste Management is one of the importance environmental issues at many developing countries. There is a lack of studies on economic analysis of solid waste management in the many cities at the national and international level. Most of the Municipal Corporation or city management is the major responsibility for better waste management. However, the local governments has been allocated budget for solid waste management without analysing cost and benefit of solid waste. Although, waste management budget is focusing on collected waste but, uncollected waste has been creating a number of socio, economic and health issues. Therefore, this chapter has presents a details review on economics of solid waste management at the various developing and developed countries. The main policy implication of the paper is to emphasis on better understanding of economic importance of solid waste management to the local policy makers.

Keywords: economics, solid waste, cost, recycling

1. Introduction

Solid waste is the byproducts of human activities such as production, consumption and distribution of various goods in the society. There are a number research has been investigated in the various aspects such as technology, innovation, recycling of solid waste management in the developing and developed countries. There are a lack of studies on economic analysis of solid waste management particularly in the developing countries, for example cost and revenue aspects [1, 2]. Most of the municipal corporation has not been maintained proper data on solid waste generation, collection, transportation and final disposal. Therefore economists are confused economic estimation of solid waste management [3]. Moreover, economic analysis of solid waste management is the most helpful to local policy makers on various aspects for instance, designing waste management tax/charges or subsidies at the municipal level [4]; cost and benefits of waste to energy [5] and determining of urban property through the better environmental amenities [6, 7]. There are various economics estimation of per ton of solid waste management in India, For example, National Institute of Urban Affairs [8] had estimated at Rs 135 for per ton of solid waste collection and disposal and another study by National Solid Waste Association [9] had calculated at Rs 417 per ton of solid waste management [3, 10]. Therefore, this chapter has discussed the economics of solid waste management and public policy at the municipal level in various developing and developed countries.

2. Economics of solid waste management

Harisch [11] was the first author who had made an important methodology contribution to study the methods of Solid Waste Management. Attention had then been shifted to the second generation of research, particularly to the work of Stevens [12] who had made substantial improvements in the Model of Hirsch [11] and those of Dubin and Navarro [13] whose papers had included some methodological innovations also. Don Fullerton and Thomas Kinnaman [14] and Beede and Bloom [15] had made generation reforms and had introduced new methods of making an econometric analysis of Solid Waste Management. Finally, a few Indian studies had made use of new methodological approaches and innovations which had used more of the statistical methods. So, more recent studies had been considered in greater detail in this section.

The First empirical study to use econometric analysis for determining, among other things, as to which form of service delivery (public or private) had an effect on the municipal cost, was that of Hirsch [11], who had studied a sample of 24 Municipalities in St. Louis country (Missouri). However, this study had used econometric model in terms of the explanatory variables were limited to the data that was an available in 1960s, the year for which he had collected the information. Therefore, the variables that were finally used to explain cost (the average costs per service) were the number of waste collection locations, the weekly collection frequency, whether the collection point was an alone or a collective agencies, the residential area, sources of finance and the form of service management, and the distinction between the municipal and the private delivery. The Article had concluded that there were significant differences in the service cost between the municipal and the private delivery. This study did not find any economies of scale with respect to the output in the service. Hardy and Greission [16] had analysed the possibility of saving costs through cooperative efforts in the collection and the disposal of the solid waste material. Heuristic algorithms had been used to determine the best locations for landfills and the best routes for the collection trucks to follow in the study area in five countries. They had discussed about the rural public service delivery problems, and had designed a method to determine the least cost solid waste management system for the selected areas. According to them the economies of scale to be realised in the disposal phase of a solid waste management system and the costs of collection were dependent on the population density and the size of the service area. The combined collection and disposal costs had indicated that the regional system could be justified for the selected study areas. The least cost system for the five countries have two regional landfills. The annual costs associated with this system of $ 447.275, was found to be substantially lesser than the amount of $ 519,815 estimated for the system with each county operating the system independently. The results of the economic analysis had indicated that a regional system for the solid waste collection and disposal could be justified from the standpoint of view of costs.

Kumar et al. [17] had applied the fuzzy regression approached of forecasting for the years 2007 to 2024. The Study had emphasised the importance of forecasting the waste composition and the significance of the waste segregation for the efficient operation of the various reuse-recycle treatment and for producing efficient disposal facilities. The fuzzy regression coefficient was estimated based on the historical data of socioeconomic conditions (in this study, per capita income, GDP, persons per household, Total Population and Density) and the respective solid waste compositions (in this study; paper waste, plastics, food items, metals, glass pieces and other wastes). The fuzzy regression analysis had estimated the variations in the composition of the wastes: the percentages of wastes paper and food wastes

were expected to decrease from 29.50 to 24.58 per cent and from 36.37 to 27.55 per cent, respectively, between the years 2007 and 2024. On the other hand, the waste of plastic contents was expected to increase from 2.74 to 3.55 per cent. The most significant changes were expected in respect of the percentage changes in the case of metals and glass, which had been estimated to increase by three times and two times, respectively, as compared to the present percentage levels. Maria Eugenia Ibarraran Viniegra [18] had attempted to examine the people's willingness to pay for making improvements in the quality of the environment that could be brought about by a proper garbage collection system. The Study had carried out an econometric estimation of the determinants of Willingness to pay for environmental quality in San Pedro Cholula and was focused on the Municipality of San Pedro Cholula, located to the North of the city of Atlixco and to the West of the city of Pueble. Its area was 712 square kilometres and its population was approximately 150,000 inhabitants. The majority (36.5 per cent) of them was agricultural engaged in activities, and next in important were people engaged in arts and crafts and workers (14.5 per cent); and businessmen (8.3 per cent). An average Willingness to pay for the Project was $ 1.85 dollar her month per household. Age was a factor of significance and it was having an inverse relationship with to Willingness to Pay. The relationship between environmental ethics and that of Willingness to pay had shown a contradiction between people's willingness to pay and their interest for environmental quality. This might be due to the fact that they did not express their true Willingness to pay because they feared that the garbage collection fees might increase. Finally, they had suggested a step towards valuation of the environmental quality and had allowed for making investment decisions with more and better information in Developing Countries.

Sarkhel and Banerjee [19] had calculated the economic value of municipal solid waste management in West Bengal. This study had interviewed 570 individual households and the mean Willingness to pay from the responses to the open-ended questions was calculated to be Rs. 12. with a median at Rs. 5.00 and a 75 per cent of the respondents expressing their willingness to pay at less than Rs.10.00, the distribution appeared to be skewed to the left with a very few extreme observations in the right-tail, pulling the mean substantially to a higher had level than that of the median. The Authors had also estimated the benefits that could derive by adopting the improved system of municipal waste management in Bally the Municipality in West Bengal. Altaf and Deshazp [20] had studied about the problem of the "Household Demand for Improved Solid Waste Management in: Pakistan" and the objectives of the study focused on integrating the demand side information into the planning process. Most of the attempts at improving the performance had been focused on the supply-side issues such as the collection, disposal and the capacity but had not yielded significant results. The sampling frame was provided by the Federal Bureau of Statistics (FBS). This census sampling frame work divided Gujranwala into 436 enumeration Blocks which represented the neighbor hoods containing 200 to 250 households. The Blocks were stratified according to income by the FBS. This stratification was retained for the study as the municipal solid waste services were provided at the block level and not at the household level. This study had followed stratified random sampling method for 1000 households. The distribution of the wastes from both the houses and the streets were tabulated at the disposal sites. About 20 per cent of the households had reported that their wastes were collected directly by the municipal disposal collectors using handcarts. The remaining households had disposed of the wastes outside their in houses with only 2 per cent of them doing so in bins provided by the municipal corporation. The most common disposal site, reported by 30 per cent of households, was an empty plot in the neighbourhood.

3. Economic instruments for solid waste management

Economic instruments are the major role in the effective solid waste management sectors of many developed and developing countries. There are a number of instruments available in the literature. The economic instruments have been used for the different aspects, for instance, reducing waste generation, improving environmental quality and human well-being [21]. Economic instruments are listed revenue generating instruments, revenue providing instruments and non-revenue instruments. First, Revenue generating instruments such as Charges taxes and subsides. Second, revenue providing instruments are includes charges and tax reductions, fiscal incentives, development rights, funds. Finally, non-revenue instruments are trade off arrangements, deposit refund system, and take back systems. **Table 1** highlights various type of economic instruments of solid waste management have adapted many developing and developed countries. Economic instruments have also help for cost-effectiveness, economic efficiency of solid waste management sector Nahman and Godfry [22]. However, the implementations of the economic instruments are especially in the developing countries very difficult due to involvement of institution and governance. For instance, in India has been generated more tones of solid waste from several years, therefore, economists they want to estimate cost of waste disposal, but there is lack of economic analysis of solid waste management [3].

Revenue generation	Revenue provide	Non-revenue
Disposal Taxes	Tax credits	Deposit refund system
Pollution Taxes	Environmental improvement fund	Tradable permit
Eco-taxes	Development rights	Eco-labeling
Pollution charges	Research grants	Product stewardship
Waste generation taxes	Host community compensation	Liability insurance
Producer charges	Tax rebates	Take-back system
Waste tipping charges	Charge reduction	Disclosure requirements
Product charges	Carbon sequestration fund	Bonds and sureties

Source: Adapted from [21]

Table 1.
Types of major economic instruments.

4. Policy issues in the solid waste management

Callan and Thomas [23] in their study on "Adopting a Unit Pricing System for Municipal Solid Waste: Policy and Socio-Economic Determinants" had carried out a detailed analysis by adopting a unit pricing system for municipal solid waste in USA. 351 Towns are included in the estimation, with 79 of these communities employing the MSW unit pricing approach and they had used the logistic regression equation for their estimation. The estimated parameters and their asymptotic standard error and each parameter gave the estimated change in the log of the odds of adopting unit pricing associated with a unit change in the corresponding independent variable. This study had empirically estimated the influence of the various theorised determinants of unit pricing adoption. From a broad perspective, this study had found that certain socio-economic and demographic characteristics appeared to have influenced the adoption decision. Although such factors were

not controllable by the policy makers, an awareness of these determinants could correct false expectations and hence diminish the risk of costly failure. This Study had suggested that a community's decision to adopt unit pricing was explainable and therefore predictable to some extent. In certain instances, the decision may be directly or indirectly controllable through policy initiatives. The relevance of these findings to MSW policy initiatives development should motivate further empirical investigations of unit pricing adaptation and the associated implications for policy makers and for the society at large.

Kinnaman [24] had used a skeletal model to develop and to frame a discussion of optimal policy design. This Model employed the virgin and the recycled materials so that the ratio of input prices was equal to that the ratio of marginal products. The Households might choose between the garbage and the recycling in a similar manner. Since agents in this simple model internalized all of the costs and benefits of their choices, resources were allocated efficiently and the optimal quantities of garbage and recycling were produced. The household utility would have an impact due to by these effects. So assume now that $u = u(c,g)$, where $ug < 0$. Under this assumption, households failed to internalise the fuel social costs of their disposal decisions. Too much garbage and too little recycling could be adopted by a decentralized economy. The majority of the households are paid traditional ways such as garbage removal fee or local property tax to the municipalities. Miranda [25] in the study on "Unit based Pricing in The United States: A Tally of Communities" had highlighted 21 communities with unit-pricing programmes and had compared the quantity of garbage and that of recycling over the year preceding the implementation of the unit-pricing system with the year following it. Results had indicated that these towns had reduced garbage by 17 per cent and had increased recycling by 128 per cent. These large estimates could not be attributed directly to pricing garbage, since in every programme curbside recycling programsme were implemented during the same year as that of the adoption of the unit-pricing programme. Callan and Thomas [26] had predicted that the implementation of a user fee had increased the portion of the wastes recycled by 6.6 percentage points. This impact increased to the level of percentage 12.1 points when the user fee was accompanied by a curbside recycling program.

Kinnaman and Fullerton [27] had demonstrated that the disposals of household wastes were constrained by two disposals an option that is garbage disposal at landfill and recycling, and then marginal cost pricing which would tend to substitute recycling for garbage disposal. But if illegal disposal or burning features was a third alternative in the household disposal choice set, then unit pricing would encourage illicit dumping. If marginal cost pricing resulted in an increase in illegal dumping, and if the externality costs are high, the efficiency losses from under- pricing services might be smaller to bear with. In fact, the initial introduction of the unit pricing system resulted only in a modest reduction in waste disposal through dumping [28]. Fullerton and Kinnaman [29] had estimated that 28 per cent of the reduction in garbage resulting from pricing garbage disposal at the curb might be due to of illegal dumping. Jenkins [30], Blume [31] and Miranda and Aldy [32] had also come out with similar findings. The unit pricing model was used in a household production framework Morris and Holthausen [33] had shown that a price increase on the conventional disposal method did not affect recycling. In the system of unit pricing, the households found it more convenient to increase the total waste reduction efforts. The resources like Time and the prices of the purchased inputs devoted to the recycling process were high but they became less effective because of the reduction of wastes. Maraco Runkel [34] had attempted to develop a partial equilibrium vintage model of a durable good in which the producers determined the output and the product durability either under perfect or under imperfect competition.

The Model differed from the previous durable goods Models in explicitly accounting for the consumption waste and for the disposal costs. This Paper had investigated as to how the Extended Producer Responsibility (EPR) in waste management had influenced the product durability and welfare. At the end of the products' life the households had to pay a unit-based waste tax that coved the marginal disposal costs also. When purchasing consumption goods, rational households anticipate the tax, adjust their demand such that less waste was generated and rendered the resource allocation very efficient. The analysis derived the first-best and the second-best regulatory schemes and, on the basis of these schemes and had, investigated as to how EPR had influenced durability and welfare. All considered EPR instruments had exerted a positive effect on durability. Under perfect competition, the first-best outcome was attained provided the EPR had assigned a few marginal disposal costs to producers at the end of the products' life; for example, through a take-back requirement combined with a regulated private disposal by the firms.

Marcello Basili et al. [35] had analysed and evaluated the costs and benefits of the New Garbage Plan (NGP), and had used hypothesis that Willingness To Pay (WTP) should reflect the value of the community of having a better environmental quality according to the contingent valuation literature. The study sample was divided into two subsets: firms and households, through the information gathered with the help of a detailed questionnaire and the, parametric and the non-parametric estimates were elaborated to analyse the willingness to pay of the population for the benefits flowing from increased SWC, increased incineration and through the cutting down of the landfills. The non-parametric from (using the double-bounded format) had produced an estimation of the minimum willingness to pay for the households and the firms, without the need to make any assumption about the true probability distribution of the values in the population. The mean willingness to pay for an increasing SWC was € 15.89 for households and € 20.89 for firms. The mean willingness to pay was easy to calculate but did not convey enough information for the policy makers. This was because of the fact that it was not possible to know the possibility of the willingness to pay to the socio-economic characteristics which could be obtained through parametric estimation producers. The Non – parametric estimates were robust, whereas the parametric estimates gave more information, and the authors had combined the non-parametric with the parametric estimates.

There are some recent literature have focused on economics of solid waste management at the national level. For example, cost and revenue aspects of municipal solid waste management, Al-Salem et al. (2014) had estimated the cost and revenue aspects of municipal solid waste management in the Great London. This study had found material resource recovery is more favorable in the context of economic in the city. Another study, Nahman [4] estimated the external cost of solid waste landfill in Cape Town, South Africa. The external costs are includes environmental as well as social cost in the estimation methodology. This study had estimated at the US$ 16 per tons of waste which has energy generation process from the municipal solid waste in the Cape Town. Aleluia and Ferrão [1] calculated the costs of solid waste management in the Asian Countries. The cost have included such as capital and operational expenditure for the municipal solid waste management. This study had estimated the average capital expenditure cost per ton US$ 21,493 for the Asian cities. Casado et al. [6] had calculated that the cost of municipal waste incineration through the Hedonic Pricing Method in England. This study had found that the impact of effective incineration the house prices range between 0.4 % to 1.3% in the study area. Sun et al. [7] had estimated the value of real estate price due to municipal solid waste landfill in Shenzhen, China through the hedonic price method. This study has found that the property value has been increased by 1.30% if the landfill away from houses.

5. Conclusion

There is lack of primary investigation on economics of solid waste management at the various municipalities in the many developing countries. The present chapter has discussed the various aspects on economics of solid waste management such as economic instrument, policy issues etc. However, the implementations of economic instruments are the major problems. Therefore, need to strengthen local institution and governance. In many developing countries like India, economists are facing many difficulties for estimating economics of solid waste management due to lack of data on waste generation, disposal and recycling [3, 36–38]. Economic estimate of solid waste is better understanding for local policy makers for designing healthy urban planning towards achieving sustainable cities. Most of the developing countries are in lack of finance and technology for effective solid waste management. Economics of solid waste management could provide a good framework for solid waste management especially cost and benefit aspects at the local and regional level [39]. Further, economics estimation of solid waste is more helpful to decision makers for designing tax/charges or other economic instrument for efficient allocation of financial and technological resources at the city level [24]. A number of Asian countries are difficult to design better solid waste management due to lack of studies on economic estimation in terms of cost of collection, transportation, segregation and final disposal [1]. Although, there are other economic problems raised due to lack of economic estimation of solid waste, for example negative externality [2]. Therefore, need to support economics of solid waste related studies at the regional, local and national level through the grants, support and guidance for better solid waste management for achieving environmental sustainability.

Author details

Muniyandi Balasubramanian
Centre for Ecological Economics and Natural Resources, Institute for Social and Economic Change, Bangalore, Karnataka, India

*Address all correspondence to: balasubramanian@isec.ac.in

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