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Successful Practices October 1, 2002

Solid Waste Management in Dhaka, Bangladesh
Innovation in Community Driven Composting

Target Area: Solid Waste Management
Time Period: 1995-2002
Research Theme: Analysis of community based initiative for solid waste management

Contents

Criteria for successful practice analysis

Analysis of successful practices may be done from various perspectives. The main focus of this successful practice analysis is capacity development for urban environmental governance. This capacity can be developed with the effective and efficient adaptation of various instruments including institutional strengthening, policies and regulatory framework, public awareness and stakeholder participation, financial mechanisms, and choice of technology. On the other side environmental governance in urban areas is primarily targeted to provide efficient and effective environmental services including water supply and wastewater, solid waste management, industrial pollution management, energy-transportation-air pollution nexus management, slums and land use, and monitoring and evaluation systems.

These aspects can be defined in a detail; however, due to limitation of the space, these aspects are briefly defined over here and then the major successful component for this study is highlighted. For institutional strengthening, the local governments being the primary institutions for urban environmental governance, the coverage includes the management and decision-making in the local governments and their vertical and horizontal linkages. Policy and regulatory framework covers the effective and efficient policies and the regulatory framework to implement or support these policies. Public awareness covers the whole range of methods and techniques to induce the awareness and its impact over the stakeholder participation. Financial mechanisms cover public sector financing, private sector financing, and public-private partnerships to assess their effectiveness and sustainability in this sector. Finally choice of technology covers the appropriate technology from various aspects including local or imported and labor or capital intensive. The broad picture of the criteria is shown in Fig. 1.

Success practice from Dhaka: This is a community driven composting in Dhaka city. The major success is due to public awareness to separate compost material at source and then civil society's role to take a well planned and well researched composting with sustainable financial mechanism and by selecting an appropriate technology to avoid bad odor. The major success is due to innovation in the marketing through a national fertilizer company, which enriches the compost to meet the requirements of the crops and local soil conditions, based on the research outcome for increased yield and for improved soil fertility. This has increased the demand multifold and provided an incentive for various community based composting plants. On the other hand, an NGO buys the compost and provides the farmers, who grow organic fruits and vegetables, which are being marketed by that NGO in the city and due to increased awareness for organic fruits and vegetables, the demand for the compost is on the rise. In Fig. 1, the various levels of gray circles shows the level of success for such instrument in this study.

Fig. 1 Urban environmental governance

Instruments / **Environmental Challenges**	Institutional Strengthening	Policies & Regulatory Framework	Public Awareness & Stakeholder Participation	Financial Mechanism	Choice of Technology
Water Supply & Wastewater Management					
Solid Waste Management					
Industrial Pollution Management					
Energy –Transportation-Air Pollution Nexus Management					
Transportation related Pollution Management					
Slums & land-use Management					
Monitoring and Evaluation (M&E) System					

1. Background

Dhaka city, solid waste generation, local government and solid waste management, and socioeconomic impact of inadequate solid waste management

1.1 Dhaka

This city covers an area of about 816 square kilometers. The climate is tropical as in the rest of Bangladesh; for most of the year it is warm with bright sunshine, but during the monsoon season there is heavy rainfall. During the winter months (November to March) it is cool and pleasant. Typical summer temperatures range between 30 to 37 degrees Celsius while in the winter it is a lot milder, ranging between 10 to 20 degrees. Annual rainfall is about 250cm and humidity around 80%

Of the total population in the city about 64.1 percent are literate. Among the workforce more than 10 percent are unemployed. Another 10 percent are employed below their qualifications. Economic indicators show that the per capita income of the people of Bangladesh is nearly US$450. GDP is US$14.89 million. Around 55 percent of people live below the poverty line in Dhaka. Half of that figure lives in slums and squatter settlements. Within a decade, the slum population has risen to about 3 million. Access to water supply, sanitation, solid waste management, and other civic services is extremely limited.

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コメント： Don't understand this meaning

Land is very scarce in Dhaka City. Only 360 sq. km. of land is available to accommodate residences, offices, services and facilities for more than 5.4 million people. An international airport, the river port, the central railway station and inter-district bus terminals are all located in Dhaka city. As the capital of Bangladesh, central government offices, large educational institutions, and hospitals are also set in Dhaka. Again, major economic activities like business, commerce and industries have been developed in Dhaka over the years. There was no designated place for disposal of wastes at the initial time. The public land was the only place for waste disposal of the city. A good number of areas have been raised from low lying ditches to high places for construction of bus terminals, play grounds and even residential sites. At present DCC has acquired one piece of large land at the outer strip of the city for disposal of waste. It would be very difficult to acquire more land for further disposing of wastes unless alternatives are explored. Table 1 shows some important indicators of Dhaka city

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1.2 Solid waste generation

In Dhaka, per capita solid waste generation is quite low; however, due to huge and densely populated city, solid waste problem in Dhaka city is very acute in comparison to many cities of the developing countries. Daily production of solid waste in Dhaka City is more than 4000 Metric Tons. Of those 200 Metric Tons of hospital and clinical waste is a mixture of toxic chemicals, radioactive elements and pathological substances. 15 to 20 percent of medical wastes are highly dangerous for human lives. These waste when dumped with other municipal wastes in the open land poses threat to serious health hazard to the city people.

The nature of solid waste is changing over time and with development. Of the solid wastes plastic and polyethylene goods also cause problems towards human health, environment and drainage system. These goods are cheaply and easily available in the markets. The users do not care to reuse them. They rather throw these things out of the door and window. An Inception Report on Control & Management of Polyethylene bags in Bangladesh shows that people of Dhaka City alone used 600 million bags a day. During floods, floodwater did not drain quickly, as one of the major reasons was due to polyethylene in the draining system. Polyethylene and plastic materials are not biodegradable. Natural process cannot decompose it. Polyethylene remains intact in the soil, disturbs the flow of nutrients to the soil and hinders entering sunlight. It destroys the beneficial bacteria of soil compaction. In the long run it affected the foundation of physical infrastructures, if there is any on the plastic dumpsite. However, due to effective regulation for banning the polyethylene bags, this problem has been overcome.

1.3 Local government and solid waste management

Dhaka Municipality was established in 1864. There are two tiers in urban local governmental bodies: City Corporations and Municipalities. Municipalities are comprised of smaller urban towns with less population. Larger municipalities are divided into a number of wards depending on the size and population. Commissioners are elected directly by popular vote. There is one Chairperson of a Municipality. He is similarly elected directly by popular vote. An elected representative represents each ward. On consideration of size, population and law and order situation, the government upgraded four big municipalities in the country into Metropolitan Cities in the 1970s.

The advantages of the Metropolitan city are that it has independent policing, judicial system and separate regulations suitable for cities' problems to control law and order situation. Considering the size, population, civic problems and importance, the government again created four Municipal Corporations in 1980. City Corporations are divided into wards. DCC is thus divided into 90 wards. Adult taxpayers of the municipalities are eligible to vote. The Mayor and Commissioners are directly elected by popular votes of the city dwellers. Elected Commissioners represent their respective wards.
The Institutional Head of the City Corporation is the Mayor. The Mayor of Dhaka City Corporation holds the status of a full Cabinet Minister. The Mayor of City Corporation along with ward Commissioners constitutes Councils of City Corporation. These Councils are responsible for formulation of policies, approving annual budget undertaking development schemes and execution of projects and programs of the respective City Corporation. The tenure of such representative bodies is five years. The Mayor chairs the Council meeting. In case of his absence the senior member of the panel of Mayor chairs the meeting.

The territory of DCC is divided into 10 administrative zones. Govt. personnel called Zonal Executive Officer heads each zone. He is aided by other departmental staff to supervise and execute the decision of the Corporation. These Departments and zones are responsible for execution of decision of the Council within their respective jurisdiction.

There are a few positions in the City Corporation kept for the officials of the National government. The government for a specified period gives posting officials for working with City Corporation on a set of terms and conditions. Government may withdraw/replace any such officials at any time for public interest.

The City Corporation is run and managed as per an Ordinance passed by the Parliament of the country. The Ordinance provides with a kind of schedule. This schedule provides with the manpower, classes of officials, their pay structure and areas of responsibilities. These officials as described in the schedule are the permanent strength of the Corporation.

Own sources of fund of the City Corporation are household tax, rents from markets, shops and establishments, fees from licenses, tolls from different temporary public places. The Corporation's own resources are not enough to cater different development activities of the city. The government's financial support has therefore become a regular phenomenon for the Corporation. In the annual budget more than 50 percent fund comes from government treasury in the form of block or total allocation. Every year at the end of financial year (June-July) an annual Budget is prepared, and submitted for Council approval at a formal meeting.

There are 12 executive departments in DCC: Administration and Establishment, Primary Health, Social Welfare, Revenue Collection, Conservancy, Estate Management, Store and Purchase, Transportation, Law, and Public Relations. Conservancy department is responsible for solid waste management including cleaning of streets and drains.

There is no independent law in Bangladesh to address the problems of solid waste. In Bangladesh, solid waste management is entrusted with the local government bodies. The responsibility of removing MSW and disposing of it lies with the City Corporation. The Dhaka City Corporation Ordinance 1983 is the only local law that gives some idea on disposal of municipal waste. Dhaka Municipal Ordinance 1983 has a provision for the removal of refuse from all public streets, public latrines, urinal drains, and dustbins and for collection and disposal of such refuse.

Moreover, due to shortage of funding, due to almost no direct user charges as well as insufficient subsidies, and other institutional constraints, the local government has not been able to effectively collect and dispose off the waste properly. Most of the waste is visible on the streets and in the drains and there is almost no sanitary landfill or any other facilities like incineration. Table 3 shows the coverage of solid waste management by the local government.

Fig. 2 shows the overall solid waste management scenario in Dhaka city.

1.4 Adverse impacts of inadequate solid waste management

In urban areas, the most adverse impact of solid waste is incidence and prevalence of various diseases. In Dhaka, malaria, dhong fever, respiratory problems, eye and skin diseases are the worst impacts. Moreover, contamination of ground water and air also leads to such adverse health impacts.
On the other hand, solid waste blocks the drainage system and creates flooding in the streets leading towards mosquitoes, bad odor, and inconvenience. Dhaka with its geographical and climatic conditions is prone to flooding; hence, solid waste in the streets and drains multiplies the health impacts and miseries. Most of the child mortality could be related with this problem, as contaminated ground water and malaria are the major causes for this mortality.

2. Community based initiatives for solid waste management

As it is clear that due to limited resources and organizational capacity, it is hard for DCC to ensure efficient and appropriate delivery of solid waste collection and disposal services to the entire city population. Therefore, DCC is encouraging community based organizations and local NGOs to organize and carryout community waste management program (mainly house to house collection and disposal).

The pilot project of Dhanmondi Solid Waste Management is the first DCC approved Solid Waste Management Pilot Project and Sheltech Consultants (Pvt.) Ltd. (SCPL) is the organization that is carrying out the project. Initially the project has started in a small chunk of Dhanmondi (Block G & H) to find out and determine more possibility of interactions and feedback to apply effectively in whole Dhanmondi area.

2.1 Achievements and shortcomings

There are similar type initiatives in various parts of the city organized by either community-based organizations or by the NGOs. However, their efforts have not so far provided a relief for the adverse impacts of inadequate solid waste management, as they only provide the service of door to door collection and then dump that waste at the dustbins located on the main street, where from DCC has to collect the waste for final disposal. The dustbins at the main streets are not being maintained and supervised properly, so animals and scavengers throw the waste out of the dustbins while searching food and recyclable materials.

On the other hand DCC is not efficiently removing the waste from the dustbins due to financial and institutional constraints. Therefore, the overall scenario for the solid waste management does not change with the community based initiatives, which are only focused on not in my backyard (NIMBY) approach.

Even, if the collection from dustbins for the final disposal is made efficient, but still the major part of the problem will remain unsolved. The final disposal requires sanitary landfill or high-tech incineration and due to poor financial viability, DCC is not in a position to spend on these facilities. Hence, the problems related with the final disposal will remain there even after the hectic efforts from the communities and efficient coordination with the DCC for the primary collection of the waste.

3 Innovative composting

In most of the developing countries, the basic issues related with the solid waste management is the lack of financial and institutional capability of the local governments and similar is the case of DCC, as we have discussed in the previous section. Hence, the community based initiatives focused on recycling and composting are very helpful to reduce the total amount of waste quite substantially. This will release the pressure on the local government for the collection and final disposal of the waste. The waste composition in the developing and developed countries is quite different; however, if the recyclable materials including organic waste for composting is separated out then the final waste could be reduced by 60% to 80%. This was the understanding for a research based NGO, Waste Concern, which brought the slogan of “waste is not waste, waste is a resource” to motivate the communities in Dhaka to compost the organic waste and earn money.

Waste Concern studied the potential of composting in Dhaka, where municipal solid waste amounts about 3000 metric tons per day. Moreover, they also studied about the informal sector industry, which is recovering recyclable solid waste. Their findings suggest that 15%of the total waste is being collected by 87,000 people in informal sector. They are mainly collecting recyclable materials leaving behind still a large amount of organic waste, which has a potential for composting and to generate economic activity besides reducing the pressure on the collection and disposal of the waste.

However, composting is not a new activity and this has been tried in many cities of the developing countries, but it has so far failed to make a difference either in reduction of the total waste by a substantial amount or for generating a popular economic activity. This was mainly due to inappropriate approaches towards demand and supply equilibrium. In most of the cities, either the supply side was not efficient, as there was not an intensive composting and neither there was a quality control of the compost material, or there was a low demand due to location and nature of agricultural activities. Hence, Waste Concern studied carefully the supply and demand aspects and outlined a good framework to carryout composting activities.

First of all they argued for decentralized composting. On the first hand, the local government was not convinced with their proposal, due to unsuccessful experiences for composting, and did not a lot a piece of land to carry out composting. On the other hand they argue that decentralized composting

system is labor intensive and less costly compared to the centralized one; it is well-suited for their waste stream, climate, social, and economic conditions; it is low cost due to easily available local materials and low cost technology can be used; it improves the community participation in source-separation and reduces the volume of solid waste at the source more effectively; it can enhance income and job opportunity for the poor, socially deprived informal workers and small entrepreneurs.

3.1 Pilot project

Waste Concern initiated the first pilot project in 1995 with the help of UNDP and Lions Club on a 1000 sq. meter piece of land. The started the public awareness campaign for the separation at source and payment of TK 15 to 60 per month for door-to-door collection, based on the survey conducted with the help of Goethe Institute in Dhaka. They developed posters and training programs for public awareness. This supply side initiative slowly started picking up the momentum. On the demand side, they conducted a detailed survey of the farmers, which revealed that there is a good demand for compost in Dhaka and in adjoining areas, as 94% of the farmers were willing to buy compost. The survey also revealed that the yield has decreased over 10 years due to excessive use of chemical fertilizer, and the organic matter in the soil was less than 1% against the critical level of 3%. Hence, compost has a buffer effect as protection against large application of chemical fertilizer.

To improve the supply side, a door-to-door solid waste collection system was introduced by Waste Concern to collect the domestic organic waste (free from toxic and clinical wastes). This collection rose to 2 tons of solid waste per day with the help of modified rickshaw vans. The number of household participation also started rising, which are paying about TK 15 per month. On the other hand, to obtain a good compost from that solid waste, without generating bad odor, Waste Concern tried two different techniques: aerobic (Indonesian), Chinese technique.

The main criteria for the best technique included: less capital intensive; located near urban residential areas; caused minimum nuisance from odors and flies; produced an environmental safe product; and well suited to Dhaka's waste stream, climate, and socioeconomic conditions. The Chinese Covered Pile System was not found appropriate for community-based projects due to odor problem, and it may be viable for large and remotely located dumpsites. However, the aerobic Indonesian Windrow Technique was viable for community based projects ass it has some odor when the windrows are turned, and that odor is tolerable. The nutrient concentration of both the composts are shown in Table 4.

3.2 Process

The process of the composting involves collection and sorting of solid waste in the resource recovery (composting) plant located within the community. Then the organic waste is heaped into piles under a shade, which allows the beneficial microorganisms to decompose the organic waste efficiently. In addition, the shed protects the compost workers from rain and heat of the sun. Pile temperature of 55 to 65 degrees Celsius is optimum for aerobic composting. To enable microorganisms to obtain sufficient oxygen, the pile is aerated using bamboo aerators. In tropical countries, the piles are liable to reach excessively high temperatures.

Turning over the pile along with the use of bamboo aerators is the method used to maintain the pile temperature. Turning associated with watering facilitates rapid decomposition and also moves the non-decomposable materials from exterior of the pile into the interior, thus providing new food source for the bacteria. Temperature of the pile determines when to turn. The temperature is monitored and records are kept of the temperature trends. Carbon versus Nitrogen ratio of 35 to 50 is optimum for aerobic composting.

However, this is slightly higher (carbon 22.6% and nitrogen 0.41%) in Dhaka. In this project, chicken and cattle manure is used to optimize the nitrogen content and also to overcome the deficiency. Sawdust is also mixed with the waste to increase air spaces, enabling proper aeration and reducing bulk weight of the compost mixture. This process has very little odor and it requires 40 days for decomposition and 15 days for maturing. After maturing the compost is screened for different grades and packed for marketing.

Recently Waste Concern is trying to reduce the decomposition time of 40 days by using inoculums (compost digester) to accelerate the decomposition. At present, 500 kg of compost is produced everyday by processing 2 tons of solid waste with the help of six female workers of informal sector.

In the plant, the areas are demarcated for waste delivery and residual removal, active composting, maturing, screening and bagging area, a store room for bagged compost, facilities for storage of equipment and personal items of workers and an office. In addition to these facilities, separate space is

earmarked for demonstration of organic farming. Generally 50% to 60& of the total site area is used for compost piles, approximately 15% for sorting and residue removal, another 15% for screening and bagging of compost, and 15% for storage and office facilities.

3.3 Marketing

Waste Concern has developed a good network with the nurseries and fertilizer marketing companies to sell their compost at a price of TK 2.5 to TK 5.0 per kg. The quality of compost is monitored in the laboratories of Soil Sciences Department of Dhaka University. Table 5 shows the nutrient value of the compost produced by this plan in comparison with the other compost.

3.4 Feasibility of the project

First, what is the cost of extracting recyclable materials from Dhaka's municipal solid waste that is left over by the scavengers? Second, how much compost can be sold in the market at prices that cover the production costs and provide a normal rate of profit. Finally, what are the intangible benefits? The reduced costs of the local government due to reduced quantity of waste should also be considered. Table 6 shows fixed costs, operation costs, and earnings of this plant. In this analysis, rent of the land is not includes, which is quite high in densely populated Dhaka and fixed capital is assumed to have a life of 5 years. The net earnings are TK317000 per year. Hence the net present value (NPV) at the 16% discount rate is TK456682.

Other benefits: The main benefit for the local government is a decrease in waste management cost by reducing huge volume of solid waste. It is estimated that a small 3-ton capacity compost plant like this can save DCC TK897900 (US$17958) per year (based on average per ton solid waste management cost including collection transportation and final disposal at TK820 per ton). This capacity plant can also save 1095 sq. meter of landfill area per year. The other benefits include the improvement in overall environment of the neighborhood by checking illegal disposal of waste on roads, drains or vacant lots as solid waste is directly collected from households; generation of employment for poor especially women and offers new prospects for small entrepreneurs to take part in the recycling business; and returns organic matter in the soil and minimizes the use of chemical fertilizers.

3.5 Innovation

Composting (demand and supply) at the level, which has been discussed so far, is considered as conventional approach with limited impact on the overall solid waste management and economic activities. However, after the stabilizing this conventional level, Waste Concerns, started their work with more communities and motivate those communities to carryout their own composting activities. Waste Concern also improved the quality of their compost during these years with the help of scientists from the university and their Nitrogen, Phosphorous, and Potassium nutrient content has raised to 2.1%, 4.0%, and 2.6% respectively. The increased supply needed to be met with increased demand levels. First of all Waste Concern also coordinated between the communities and the original buyers (nurseries and fertilizer shops in Dhaka) to buy the compost produced at the community-based plants.

The most innovative part of this composting is the enrichment of the nutrient and countrywide marketing/sale of the compost. This became possible, when Waste Concern signed a partnership agreement with Map Agro Ltd. Bangladesh, a fertilizer marketing company, which purchases compost in bulk and markets it after enriching the compost according to the crop and soil requirements. Map Agro has established Nutrient Enrichment Organic Manure Production Plant at Uttara, Dhaka, where they enrich the compost, which they buy at the price of TK 2.5 (US$ 0.046) per kg and sells, after enrichment, at a price of TK 6 to TK 8 (US$ 0.11 to US$ 9.148) per kg in open market. Map Agro has already invested TK 2.5 million (US$ 46296) on the plant. The success of their compost and marketing has raised the demand up to 10,000 metric ton against the 500 tons being produced by Waste Concerns. The other important innovative part is an agreement with PROSHIKA, one of the largest NGOs in Bangladesh, to sell the compost. PROSHIKA supplies the compost to the farmers in rural areas adjoining Dhaka, who produce vegetables using only compost without adding any chemical fertilizer (organic farming). Then PROSHIKA purchases all the organic vegetables and sales those at the three centers in Dhaka.

These innovative ways have given composting a new dimension to make a real impact on solid waste management, as demand exceeds the supply, and also to generate various economic activities in the various sectors along with protecting the soil for higher agricultural yield.

Outcome: The most important outcome of this success is the partnership between the local government and the communities for effective solid waste management. Now DCC is in negotiations to a lot a piece

of land at the landfill site for composting. Therefore, it is evident that communities can pressurize the governments, not only through protests, but also by showing their successful efforts. Hence, this will be a triangular partnership among public, private, and communities.

4 Replication of this success story

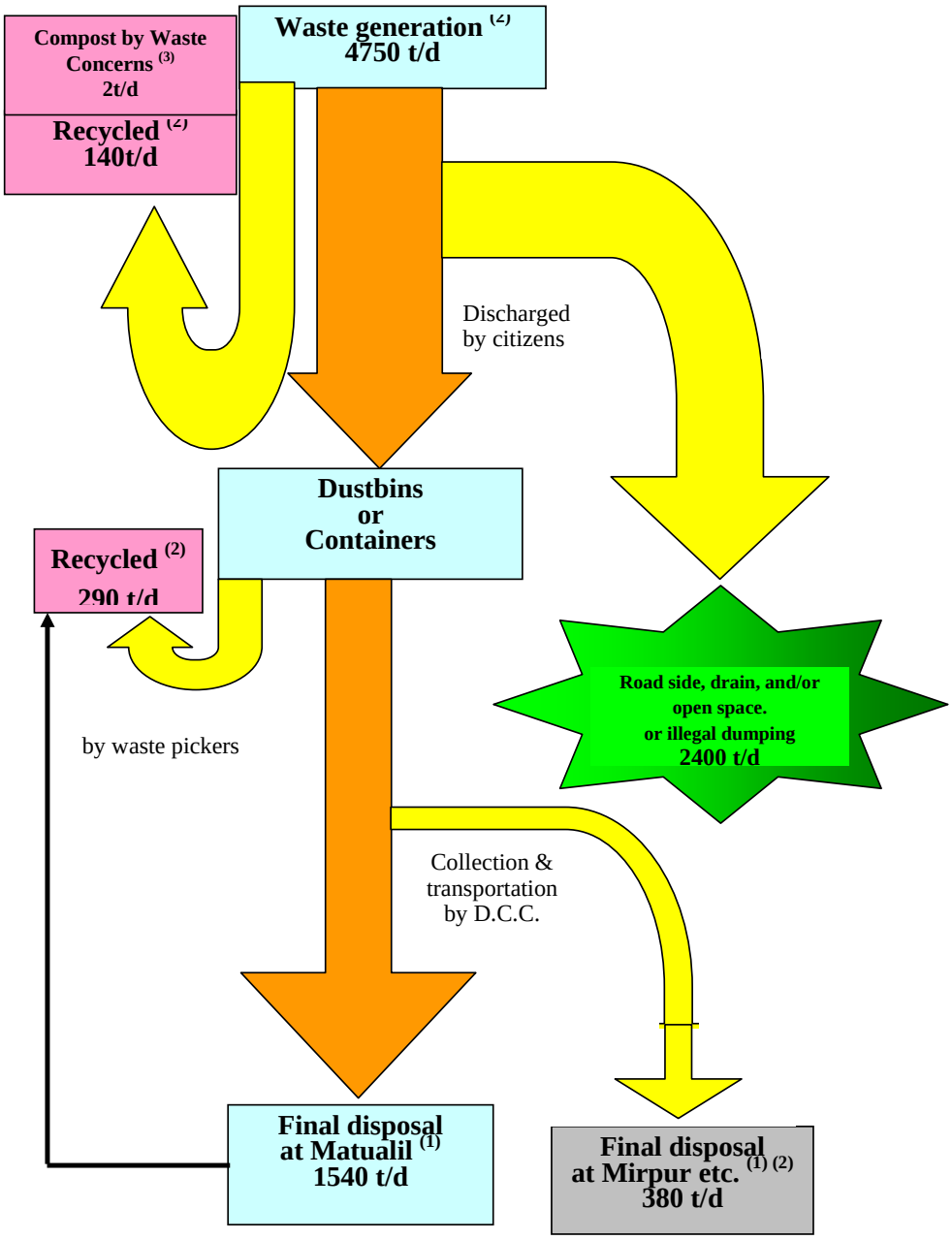
This success story is can be adapted widely in most of the developing countries. We can divide this success story into various parts, which can be replicated not only for composting or for solid waste management, but also for most of the environmental issues in the urban areas of the developing countries. First of all community based approaches and public awareness is the most important factor for any initiative. As we have seen that all the community initiatives may not be successful; however, these initiatives motivate communities to come up with new ideas, as Waste Concern came up with composting, when only door to door collection failed to produce any impact. Secondly, the efforts should be first made to establish the conventional techniques and then try to innovate new techniques like enrichment and marketing of the compost in this study. This also requires exploring new partnerships and ideas and trying to get intensive involvement of private sector and other civil society organizations, if public sector is not responding at the beginning. Thirdly, we saw that public sector responds if the communities or private sector make their efforts and bring the success stories to improve the public opinion and pressure on the local governments.

Hence, this story should not only be replicated for innovative composting to improve solid waste management, but should be replicated for other challenges including wastewater, air pollution, and so on.

5 Conclusion

We can conclude this successful practice by identifying the important outcomes. First of all, the successful practice needs a logical understanding of all the actors, issues, efforts, and outcomes. Then an in-depth analysis can lead to highlight the successful efforts and their possibility for replication. Therefore, we presented a comprehensive scenario for Dhaka City and its solid waste management by all the major actors including local government and the civil society. This clearly shows that all the local governments have various institutional, regulatory, and financial constraints. However, the innovate and community driven projects can reduce the solid waste for final disposal and these projects can also provide political impetus for the local governments to cooperate and encourage these community initiatives.

Fig. 2 Solid Waste Stream in Dhaka City



Source: (1) Survey of our JICA project, 2000

(2) Survey was conducted under the guidance and supervision of Dr. Shamsul Haque Bhuiyan, 1999

(3) Enayetullah and Sinha (2000)

Table 1 Socioeconomic and environmental indicators of Dhaka

Urban Indicators

City Development Index	Utilities	Environment	Health	Education
41.16	57.24	63.88	35.22	13.28

Socioeconomic Indicators	
Total Population (Metropolitan Region)	6.61 million
Annual Population growth rate	5.52%
Average Household Size	5.6
City Product Per person US $ 1993	219
Poor Households	54%
Under five mortality rate	10.7%
Primary school classrooms	56.6
Secondary school classrooms	75.8
Hospital beds per person/ bed	924
Infrastructure Indicators	
Water	80.0%
Sewerage	43.7%
Electricity	73.8%
Telephone	23.0%
Consumption of water liters/per/day	119.0
Median Price of Water US$93/cu.m	0.40
Environmental Management Indicators	
Waste Water Treated	55.1%
Solid Waste Generated (ton/capita/year)	0.01
Households with Regular waste Collection	50.3%
Disposal Methods for Solid Waste in Dhaka	
Landfill	50.0%
Incinerator	0%
Open Dump	5.0%
Recycling	30.0%
Other	15.0%
Local Government Indicators	
Revenue per capita (US$93/per/yr)	27.7
Capital Expenditure	25.3
Debt service charge	5.8%
Local government employee per 1000 people	6.2
Local government wages in the budget	15.7%
Contracted recruitment expenditures	7.4%

Source: Urban Indicators Program Phase I: 1994 – 1996
(http://www.hsd.ait.ac.th/ihsa/si/a13lc/dhaka/ui.html)

Table 2 Composition of Solid Waste in Residential and Industrial Areas

Average Composition of Solid Waste for Different Areas

Area Type	Food waste	Paper	Polythene	Cloth	Garden Trimming	Brick Wood Metal and Glass	Leaves and branches	Shredded Skin and Leather	Density
CA	35.77	13.33	12.85	29.57	0.00	4.77	3.73	0.00	450
IA	19.89	33.77	18.50	0.27	0.00	1.09	0.25	26.19	456
HIG-R	69.52	6.60	6.32	1.83	2.18	5.00	8.56	0.00	518
UMIG-R	56.72	4.30	16.42	7.64	2.30	7.50	3.84	1.30	438
LMIG-R	73.01	7.06	15.32	1.55	0.00	1.49	1.67	0.00	468
LIG-R	89.25	1.86	6.39	1.38	0.00	0.00	0.43	0.00	650

CA - Commercial Area
UMIG-R - Upper Medium Income Group-Residential
IA - Industrial Area
LMIG-R - Low Medium Income Group Residential
HIG-R - High Income Group Residential
LIG-R - Low Income Group-Residential

Average Composition of Solid Waste Collected from Different Locations of Dhaka:

Location type	Vegetable matters and remaining of fruits (%)	News paper (%)	Card hoard (%)	Tree trimmings and straw (%)	Metals (%)	Glass (%)	Stone, ceramics and debris (%)	Plastics and Polythene (%)
Mixed area	70.12	4.16	0.16	10.76	0.13	0.25	4.29	4.71
Industrial	26.37	7.59	0.00	4.32	0.00	0.00	9.49	6.03
Commercial	62.05	6.28	0.00	2.86	0.28	0.37	3.79	4.62
Residential	59.91	11.21	0.00	8.76	0.15	0.00	2.30	17.67

Batteries (%)	Clothes (%)	Others (%)
0.00	4.57	0.85
0.00	46.20	0.00
0.00	18.93	0.82
0.00	0.00	0.00

Average Moisture Content (%) of Solid Waste:

Area	Food Waste	Paper	Polyethylene	Cloth	Garden Trimming	Brick, Wood, Metal, Glass	Leaves and Branches	Shredded Skin and Leather
CA	70.02	66.64	64.07	51.75	0.00	18.96	68.74	0.00
IA	66.67	43.72	43.42	60.91	0.00	21.85	80.77	48.03
HIG-R	56.08	48.88	54.44	43.42	58.97	32.93	47.26	0.00
UMIG-R	67.85	53.47	43.92	27.18	59.55	12.22	46.72	48.06
LMIG-R	61.31	42.54	42.55	52.58	0.00	27.54	57.60	0.00
LIG-R	44.63	53.45	31.99	53.76	0.00	0.00	53.24	0.00

Chemical Analysis of the Solid Wastes of Dhaka City

Location Type	Average Constituents (%) by weight.							
	Moisture	Carbon	H2	N2	S	Ash	Oxygen & others (by difference)	Calorific value Btu/lb.
Mixed	65	10.30	1.76	0.63	0.01	20	2.73	1735
Industrial	60	9.90	2.00	0.58	Negligible	25	2.52	1680
Commercial	54	17.81	1.92	0.46	0.02	22	3.79	2254
Residential	50	26.06	3.53	1.62	0.01	18	0.78	2600

Heavy Metal Content of the Ash Residue of the Refuse of DCC

Sample Location	As mg/kg Ash	Hg mg/kg Ash	Cd mg/kg Ash	Cr mg/kg Ash	Cu mg/kg Ash	Pb mg/kg Ash
Industrial	2.69	0.15	1.51	40.29	228.09	161.23
Commercial	3.43	0.06	0.3	47.19	161.46	174.76
Residential	3.18	0.11	0.49	31.91	45.31	14.05
Mixed	3.66	0.19	0.66	34.49	117.2	41.05

Source: Dhaka City Corporation website (http://www.dhakacity.org/html/ana_waste.html)

Table 3 Solid Waste Management by Local Government

Data Source	Assumed collecting by the DCC (%)	Volume collected by the DCC (m^3)	Assumed density of Solid Waste (ton/m^3)	Quantity disposed at dump sites (ton/day)	Solid Waste generation (ton/day)
BKH, 1985-86	50	937	0.56	520	1040
DCC, 1985	50	1600	0.56	888	1776
LBI, 1990	50	NA	N.A	1250	2500
WHO, 1990	50	1381	0.80	1105	2210
MMI, 1991	50	1174	0.58	683	1300
JICA, 1991	50	N.A	N.A	770	1540
PAS, 1997	75-80	N.A	0.35	N.A	3000-5000
RSWC, 1998	50	N.A	0.60	600-800	1200-1600
BCAS, 1998	50	N.A	0.604	1199	2398
DCC, 1999	Little over 50	N.A	0.689	1800	3500

Source: Dhaka City Corporation website (http://www.dhakacity.org/html/ana_waste.html)

Table 4 Comparative analysis of nutrient concentration by two composting methods

Compost method	p[h]	Nitrogen (%)	Phosphorous (%)	Potassium (%)	Sulfur (%)
Aerobic (Indonesian)	7.60	1.64	0.96	1.60	0.45
Chinese	7.60	1.44	0.89	1.40	0.45

Source: Enayetullah and Sinha (2000)

Table 5 Comparative analysis of nutrient concentration in compost

Compost produced	p[h]	Nitrogen (%)	Phosphorous (%)	Potassium (%)
By original Indonesian method	7.8	1.40	0.36	0.66
In international market	7.5	1.10	0.40	0.50
By Waste Concern	7.6	1.64	0.96	1.60

Source: Enayetullah and Sinha (2000)

Table 6 Fixed cost, operational cost, and earnings from the compost (1US$ = TK50)

Fixed costs

Item	Taka	US$
Construction of composting shed with drainage facility of 2235 sq. feet @ TK120/sq. feet	268,200	5,364
Construction cost of sorting platform with shed of 375 sq. feet @ TK120/sq. feet	45,000	900
Construction cost of office and toilet facility of 100 sq. feet @ TK500/sq. feet	50,000	1,000
Purchase of 3 rickshaw vans @ TK15000 for each	45,000	900
Water and electricity connection	50,000	1,000
Equipments for composting, and dress for workers	50,000	1,000
Total fixed cost	*508,200*	*10,164*

Operational costs (per year)

Item	Taka	US$
Salary of six workers @ TK1000/month	72,000	1,440
Salary of two van drivers @ TK1500/month	36,000	720
Salary of four waste collectors @ TK500/month	24,000	480
Salary of plant manager @ TK 5000/month	60,000	1,200
Water and electricity bill	5,000	100
Raw material for compost	12,000	240
Total operational cost	*209,000*	*4,180*

Earnings (per year)

Item	Taka	US$
Sale of compost 500 kg from processing 2 tons of solid waste per day for 320 days @ TK2.5/kg	400,000	8,000
Charge for house to house waste collection services rendered @ TK15/household/month from 700 households	126,000	2,520
Total earnings	*526,000*	*10,520*

Source: Enayetullah and Sinha (2000)