Using Capacity Factors For Multicriteria Decision Making in Sanitation Options

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Abstract

To reduce deficiency in service capacity of municipal sanitation system (MSS) in lower income countries (LICs), national governments and international agencies such as the World Bank and United Nations focus primarily on policies, programs and technologies. However, previous interventions narrowly focus on building physical infrastructure that are at times inappropriate to the context of its environment and *lack comprehensive focus on capacity building over the lifecycle of the infrastructure*. This paper identifies seven capacity factors that must be addressed in order to provide sustained access to MSS infrastructure: (i) institutional, (ii) human resource, (iii) technical, (iv) economic / financial, (v) environmental/natural resource, (vi) social/cultural, and (vii) service capacity. These capacity factors synergize to assure service capacity in higher income countries (HICs). However, their interaction in LICs is often neglected and may result in a deficient service capacity. Hence a failure to explicitly accommodate them in planning for MSS in the LIC will result in services that cannot sustain the demands of the local context in which they are built. A case study and lessons-learned in using these capacity factors for sanitation options analysis in a suburban town with more than 300,000 populations in a South-East Asian LIC is presented.

1. Introduction and Problem Definition

1. Current responses to deficient municipal sanitation system (MSS) in lower income countries (LICs) by national governments and international agencies such as the World Bank (WB) and United Nations Development Programme (UNDP) focus on three primary factors to reduce this deficiency in service capacity: (a) policies, (b) programs, and (c) technologies. The weakness of previous interventions is the lack of a comprehensive focus on *capacity building* over the lifecycle of the infrastructure for these services. Worse are solutions that focus narrowly on building physical infrastructure that are at times inappropriate to the context of its environment. Consequently, the net is cast too close to the symptom of the problem, rather than striking at all its root causes. In fact deficiencies in municipal sanitation service capacity, either in quality or quantity, are symptoms of more deeply rooted factors endemic to sanitation systems. This paper identifies seven capacity factors that must be addressed in order to provide sustained access to municipal sanitation infrastructure. These capacity factors are; institutional, human resource, technical, economic/financial, environmental/natural resource, social/cultural, and service capacity (Louis and Bouabid, 2003). These capacity factors combine to assure service capacity in higher income countries (HICs) but their interaction in lower income countries (LICs) results in a deficiency in service capacity. Hence a failure to explicitly accommodate them in planning for MSS in the LIC will result in services that cannot sustain the demands of the local context in which they are built.

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2. Description of Approach

2. This research postulates that there are seven such capacity requirements that determine the long term success or failure of a municipal sanitation system. When they are present in sufficient amounts and interact appropriately, they determine the long term success of the municipal sanitation system at sustaining the demand for services. These capacity requirements are the following and illustrated in Figure 1: (1) institutional capacity, (2) human resources capacity, (3) industrial capacity, (4) economic/financial capacity, (5) environmental/natural resources capacity, (6) social/cultural capacity, and (7) service capacity.

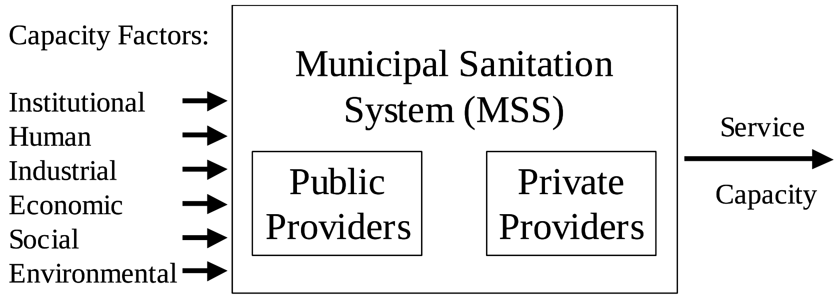

Figure 1: MSS Systems Diagram

Institutional Capacity refers to the body of laws and regulations, administrative agencies and procedures for the governance of MSS. In MICs such as the United States, MSS function in the context of well-established institutions at the national, regional and local levels. These are structurally decoupled from the political process of changes to the executive, legislative or judicial branches of government. However, in LICs such stability is not assured and the political process exerts direct and sometimes contradictory effects on the goals of MSS (Oro, 2000).

Human Resources Capacity refers to the stock of professionals, skilled labor, and unskilled labor available to MSS. MSS planning in LIC, must reflect the existing mix of expertise and grow in technical complexity as the skilled and professional pools increase. Investments in overly complex systems are costly, never recovered, and inappropriate to the conditions set by local capacity factors (Gupta and Van Beukering, 2000a).

Social Capacity **refers** to the socio-cultural values that underlie the way sanitation in general is perceived in society and the way MSS delivery is perceived as a practice by stakeholders. For example, in many parts of Asia, organic waste has traditionally been seen as a resource and has been used as animal feed, to fertilize land, and as a source of fuel for cooking. Accordingly, these perceptions greatly affect public participation in service activities for both suppliers and users of the service. Documented MSS planning through consultations with communities and NGOs are few but have been proven to be highly effective (Wright, 1997).

Industrial Capacity refers to the supply chain that supports the hardware and service needs of the MSS industry. This includes such services as the maintenance and repair of vehicles and equipment along with such hardware as machinery, tools, and spare parts. Where these hardware and services are not available locally, they have to be imported at higher cost, which may compromise the availability of the service. In the LIC, an informal sector often provides low quality supplementary services (Gupta and Van Beukering, 2000b). However, this informal sector is incapable of meeting the demand for sanitation services on its own, with the result that the barrios and shantytowns in urban areas are degraded by filth and related unsanitary conditions.

Economic and Financial Capacity refers to the markets for MSS, financing mechanisms (bonds, credit ratings etc.), and availability of cash to fund ongoing system operations. Capital investments usually come from general taxes or overseas development assistance (ODAs). Hence, economic resources for MSS are often variable and sporadic. Private businesses often subsist on government contracts that also depend on these same resources. Private financing mechanisms are generally not available for MSS in LIC (Blight & Mbade, 1998a).

Environmental and Natural Resources Capacity refers to the natural sources and sinks of the sanitation services systems. These are the surface and groundwater supplies for DWS, land and surface water discharges for WST and land and air quality for MSW landfilling and burning. As urban populations in the LIC increase, more of these resources will be consumed for MSS, even as they are competitively required to meet the other demands of development.

Service Capacity refers to the resultant service volume supplied by the providers of a sanitation service in a designated area. More detailed discussion on the different capacity factors are found in Appendix 1.

3. An assimilation of capacity requirement needs can be achieved through the identification of relevant criteria that have strong correlations to specific capacity requirements. In this fashion, the options for meeting the needs are in appropriate context of all the requirements that affect service capacity. Table 1 summarizes the links between capacity requirements and project criteria. The following section details their relationships.

Table 1
Capacity Requirements Link to Criteria

	Capacity Requirements						
Criteria	Institutional	Human	Industrial	Environmental	Social	Economic	Service
Investment Cost	X					X	X
O&M Cost	X					X	X
Price/unit (Affordability)					x	X	X
Employment level		x	x		x	X	X
Local resource use	X	x	x	X	x	X	X
Market development			x			X	X
Pollution Impact				X		X	X
Health impact		x			x	X	X
Benefits to the poor					x	X	X
Capacity potential						X	X
Technical feasibility		x				X	X
Inter-service impact	X			X			X

4. Investment cost, O&M cost, and price/unit directly correlate with financial capacity, which refers to the markets for MSS, financing mechanisms (bonds, credit ratings etc.), and availability

of cash to fund ongoing system operations. Financial capacity for investment recovery is critical to ensure project success and sustainability. Capital investments, typically derived from general taxes or overseas development assistance (ODA), are likewise critically affected by the public institutional framework governing these processes and must be taken into account in project selection.

5. The criterion for employment level is linked to the need to enhance human and industrial capacity, as well as economic capacity. Human resources capacity refers to the stock of professionals, skilled labor, and unskilled labor available for MSS projects classified in Table 4. In LICs, labor-intensive processes are usually preferable in order to generate jobs in the community. Increased employment in the region anticipates increased spending by consumers, which can potentially boost local economy.

6. Local resource mobilization aims to maximize the use of the available supply of resources indigenous in the area without sacrificing the sustainability of these resources. This also refers to available technical capabilities in the community to actually run the sanitation facility. The criteria relates to making the most out of local resources in order to reduce dependencies from external support. Accessible local resources for all the capacity requirements: institutional, human, industrial, environmental, social, economic, and service resources should be accounted.

7. Market development primarily concerns economic capacity and industrial capacity. Industrial capacity refers to the supply chain that supports the technology and service needs of the MSS industry. Where the supply chain for this technology and supported services are not available locally, they have to be imported at higher cost, which may compromise the availability of the service. Hence an adequate support system for MSS should also be developed locally. Studies also argue that adequate provision of sanitation services is a prerequisite for enabling socio-economic development. Certain industrial sectors will benefit from the input as well as output of the sanitation processes.

8. Pollution impacts affects environmental and natural resources capacity, which refers to the natural sources and sinks of the sanitation services systems. These include the surface and groundwater supplies for DWS, land and surface water discharges for WST and land and air quality for MSW landfilling and burning. These impacts to the environment have corresponding economic costs in terms of clean-up costs, health costs, and the like.

9. The Environmental and Planning Management (EPM) Source Book by the United Nations Environmental Program (UNEP) additionally suggests the criterion, benefits to the poor. This type of criterion is suggested by the United Nations as one of the crucial goals for LICs to combat poverty alleviation and improve social capacity.[i] As discussed earlier the hardest hit by deficiencies and shortages of the sanitation services are the poor.

10. Capacity potential and technical feasibility refer to the sustainability and life of the project or facility. These criteria concern the technical aspect of the project that obviously determines the price tag. Hence, the financial capacities in order to afford certain technologies can be limitations. Furthermore, the criteria must take into account the human capacity of possessing and expanding the capability of managing and maintaining the capacity over the lifetime of the project.

3. Results and Proof of Concept: Town X Case Study

11. Although the case study features solid waste, the process involved can readily be applicable to water or wastewater cases. Appendix 2 details the case study for the options analysis of solid waste alternatives for Town X. Due to intellectual property and confidentiality agreements, the town used in the study would like to remain anonymous. A multi-criteria decision making methodology was employed, grounded on the capacity factors described above. Table 2 lists these criteria according to capacity factors. An adhoc committee was formed to determine this list and use it to evaluate solid waste alternatives.

Table 2
List of Criteria for Town X MSW, 2002

Capacity Factors	Criteria
Institutional	Prohibition/ Support from laws and regulation
Human/Organizational	Job/ employment level
Industrial	Local resource mobilization
Environmental	Pollution impact Impact to wild-life habitat Impact to cultivable areas
Economic	Impact to other economic sectors (Market development) Investment cost Operational cost Impact to property values Affordability
Social	Health Impact Impact to urban poor Consensus (acceptability in community) Utilization Convenience
Service/ Inter-service	Capacity/ Capacity Expansion Potential DWS Impact WST Impact Short-term/ Long-term dimension Technical feasibility

4. Lessons Learned

12. Waste transfer topped environmental, social, and economic categories. However, undue reliance on other municipality made waste transfer an unpopular alternative for the committee since there is no long-term guarantee for the availability of the final sink. Although waste transfer scored high in the environmental category, environmental costs were still being incurred by somebody else's "backyard". Economically it was simply cheapest and socially it was easiest to perpetuate the status quo.

13. Composting was institutionally preferred by the central Government and the Department of Natural Resources. It had the most potential to mobilize local resources, generate employment, and develop the local economy. It scored highest with service capacity offering a long-term solution, flexible capacity, and more technical feasibility for LICs. Furthermore, the committee expressed partiality to the criterions where composting scored highest namely, 1) benefit to urban poor, 2) market development potential, and 3) long-term dimension. This tipped the scale to composting, gaining heavier points for these weights.

14. Brainstorming sessions from the ad hoc committee not only yielded good descriptions and illustrations of impacts but also fostered participation and solidarity. The adoption of the

seven capacity factors also enabled the early identification of potential problems and formulation of intervention in different areas of the project implementation. An immediate benefit of using the analysis was in leveraging more support from the National Government, private sector, and other collaborative organizations.

Appendix 1: Definition of Capacity Factors/ Requirements

Institutional Capacity

Institutional capacity refers to the body of laws and regulations, administrative agencies and procedures for the governance of MSS. In HICs, MSS function in the context of well-established institutions at the national, regional and local levels. These are structurally decoupled from the political process of changes to the executive, legislative or judicial branches of government. However, in LICs such stability is not assured and the political process exerts direct and sometimes contradictory effects on the goals of MSS.[ii]

Traditionally, management of municipal services is a responsibility of government at national and other levels of political administration and is therefore commonly performed by public officials. The ministries customarily involved are Public Works, Health, Environment and Natural Resources, Local Government, Social Welfare, and Community Development.[iii] Generally at the national levels, there is a body charged with responsibility for formulating policies, planning, coordinating activities, monitoring and evaluating projects and programs. The responsibility is placed under one lead ministry. The policies are implemented through national service boards or corporations in charge of the services.[iv] However, in the transition from governance at the national level to implementation at the local level, systematic planning for sanitation services is typically neglected.[v] Generally, the sanitation service operation is manned by crew of unlicensed laborers under the authority of the local government.[v] Furthermore, since daily management does not lie within the jurisdiction of a single local policy-maker, appropriate planning for local conditions is virtually impossible. This absence of system planning is compounded the lack of laws, regulations, and administrative structures and procedures necessary to assign responsibility and accountability for MSS delivery.[3]

Human Capacity

Human Resources Capacity refers to the stock of professionals, skilled labor, and unskilled labor available to MSS. MSS planning in LIC, must reflect the existing mix of expertise and grow in technical and administrative complexity as the skilled and professional pools increase.

MSS may be broken into four classes in order to analyze their human resource requirements. Table 3 summarizes this classification. Based on this classification, the human resources capacity requirements may be analyzed qualitatively as shown in Table 4.

Table 3
Classification of MSS Systems

Class	Name	Description
I	No Service	- no infrastructure - no service provider - no formal or informal service
II	Uncontrolled Unofficial Service	- no infrastructure

		- no formal service provider
		- informal service
		    - uncertified local provider
		    - pirated
		- neighborhood level

III	Uncontrolled Official Service	- no infrastructure
		- formal service provider
		    - administrative
		    - operations
		- informal service provider
		- multi-neighborhood: community level

IVa	Controlled Official Service - Distributed Local Systems	- infrastructure - formal service provider - informal service provider - consolidated communities *- distributed local systems*
IVb	Controlled Official Service -Centralized Regional Systems	- infrastructure - formal service provider - informal service provider - consolidated communities *- centralized regional systems*

Table 4
Human Resources Capacity Requirements for MSS Systems

MSS System Class	Human Resources Group					
	Professional		Skilled Labor		Unskilled Labor	
	Tech	Admin	Tech	Admin	Literate	Illiterate
I	Low	Low	Low	Low	Low	High
II	Low	Low	Low	Low	Med	High
III	Low	Low	Med	Med	High	High
IVa	Med	Med	Med	High	High	Med
IVb	High	High	High	High	Med	Low

The bulk of demand for MSS in urban settlements in LIC is from favelas, shantytowns and other informal settlements that throng the central area. Whereas centralized infrastructure and administration can meet the needs of cities in higher income cities, such systems are inappropriate for the conditions that determine demand in LIC. It is imperative that MSS planning for LIC reflect this reality. A failure to do so will result in the common case of LIC that make investments in large centralized systems that are costly, improperly operated, and unable to sustain service for the bulk of local demand. [vi]

In LIC, the relatively few professionals and experts in MSS, primarily from the civil or chemical engineering professions (see Table 5) function in the managerial and consultant positions.[vii] Supervisory and blue-collar jobs in these industries come from low-income populations. Waste management as a field of study in particular is relatively scarce in LICs due to the lack of skills, expertise and interest in the field.[vi] As a profession or trade it is further viewed as an inferior occupation, the work dirty and unimportant.[vi] For example in India, people of lower caste levels undertake waste activities.[vi] Since these activities are labor intensive and involve livelihood performed by the low-income marginalized people in the metropolis, informal sectors thrive in MSS. By sorting and collecting waste materials, providing and distributing water, or cleaning septic tanks, the informal sector accounts for 1-2% of the workforce in large cities.[viii]

Table 5
Engineering Workforce in Selected Countries

Country	Year	Total No. of Engineers	Engineers/ 1,000 Population
High-Income			
USA[a]	1995	3,839,000	14.30
Canada[b]	1997	165,758	5.60
Middle-Income			
Estonia[c]	1998	16,800	11.85
Philippines[d]	1995	38,919	0.57
Low-Income			
India[e]	1990	3,494,544	3.76
Pakistan[f]	1993	13,000	0.08

a) US Bureau of Census, 1995
b) National Survey of the Canadian Engineering Profession in 1997: Summary of Findings
c) Statistical Yearbook of Estonia 2000
d) Commission on Higher Education (CHED), Philippines
e) Institute of Applied Manpower Research, I.P. Estate, Mahatma Gandhi Marg, New Delhi
f) Institution of Engineers Pakistan

Industrial Capacity

Industrial Capacity refers to the supply chain that supports the technology and service needs of the MSS industry. This includes such services as the maintenance and repair of vehicles and equipment along with such hardware as machinery, tools, and spare parts. Technology-intensive centralized municipal sanitation service providers, such as automated water treatment plants or anaerobic digesters for sewage treatment, are dependent on chemical supplies and require consistent scheduled maintenance for continuous reliable service. Where the supply chain for these services is not available at a low opportunity cost, the services are inappropriate for the industrial capacity of the location.[7] In such cases, it is not economically efficient to use those technologies to provide the service. Instead, a system that is less technology-intensive should be selected with the understanding that the region will evolve to a more sophisticated system when the supporting capacity requirements, are in place at a feasible cost.[ix]

Economic and Financial Capacity

Economic Capacity refers to the markets for MSS, financing mechanisms (bonds, credit ratings etc.), and availability of cash to fund ongoing system operations. The term market includes public and private service providers, provisions for rate setting, fees and collection mechanisms to offset costs. The success of these markets is closely tied to institutional capacity requirements for the regulation of the natural monopolies that emerge in the provision of sanitation services.[x] This is most pertinent in view of the trend toward privatization of MSS in both LIC and HIC.[xi,xii] For example, the city of Manila contracted out 100% of waste collection and privatized its water and sewer service.[xiii]

Trinidad and Tobago has a majority of its waste collection contracted out to private companies.[xiv] Alongside the formal private sector in LIC is the informal sector, which often provides supplementary services. Though this research includes contributions from the informal sector in its assessment of service capacity, extending the analysis of markets to include informal transactions, was beyond the scope of this work.

The traditional approach to MSS infrastructure financing in HIC is through government grants and municipal bonds.[xv] At present a sizable portion of municipal budgets in LICs is spent on sanitation services, as much as 50% of municipal expenditures are allocated for solid waste management.[vi] However, even with these levels of expenditure, services are far from desirable with an average of only 50% of the generated solid waste collected in cities.[xvi] Thus, in the case of LIC, capital investments for MSS usually come from general taxes, government-funded international loans, and overseas development assistance (ODA).

These three sources are inappropriate for financing MSS capital improvement and operations. General taxes provide a variable and politically-dependent source of financing to MSS providers that may not reflect actual system costs and financing need. In addition, general taxes are unable to send a signal to service consumers of the price of the MSS they receive. Thus, users have no price incentive to limit consumption and those with access to services are driven to overconsume. Government-funded international loans, from agencies like the World Bank and regional development banks, provide relatively low interest financing over long repayment periods. However, these funds place a burden on the MSS provider to generate earnings and/or contribute to GDP at a rate that exceeds the rate of interest on the loan. In fact, the rate of growth of its contribution to GDP will always be the net of the true performance and the loan interest rate. This is a high expectation for new system in an LIC with limited management and institutional resources. The likelihood is great that the MSS will be unable to meet this expectation, leaving the system and government backers with a net drain on the national income as they must allocate earnings to service the foreign debt.

Overseas development assistances, in the form of direct grants or subsidies on capital imports are sporadic in timing, amount, and volatile from currency exchange. ODA may also come with preconditions, such as spending for institutional change or environmental protections that are outside the jurisdiction of the MSS provider. Furthermore, since ODA involves the national government, its use by MSS providers will inevitably entail political involvement in the management of the MSS. Such involvement detracts from the MSS provider’s goal of efficiently delivering safe, reliable municipal sanitation services.

Consumer’s economic capacity is also becoming increasingly critical for planning sanitation systems. Willingness-to-pay surveys have been undertaken to assess the viability of user fees.[xvii] Many systems have been unsuccessful due to the inability of consumers to afford the type of service provided, which in turn undermines funding for capital investment, and operation and maintenance.

Environmental Capacity

Environmental Capacity refers to the carrying capacity of the air, water and soil media to absorb the environmental impacts of existing and planned sanitation services. For example, non-attainment areas for criteria air pollutants would most likely be denied permits for new waste incinerators. However, in the municipality of Town X, which is the subject of the case study for this thesis, air quality already laden with pollutants from thousands of motorcycles with uncontrolled two-stroke engines, is subjected to the emissions of hundreds of open fires, lit to burn uncollected MSW.

Natural Resources Capacity refers to the stock of natural sources required for the sanitation services. Thus it refers to the volume and quality of surface and groundwater for drinking water supply, the availability of land and the flow rate of receiving waters for effluents from wastewater treatment plants, the height of the water table for septic tanks and pit latrine systems, the acreage and soil type of land for landfills and composting facilities, as well as the energy capacity to support sanitation activities. As urban populations in the LIC increase, more of these resources will be consumed for MSS, even as they are competitively required to meet the other demands of development.

Social Capacity

Social capacity refers to the ability of the affected community to organize around a shared perception of the need for MSS, to formulate a common demand for service from municipal authorities, and to participate in community-based provision of MSS where appropriate. Though the affected community may not speak with one voice on social issues, the first step in building social capacity for MSS is the ability of the affected community to forgo its differences in order to achieve the greater good, in this case, MSS. The town of Town X, Nelson County – Virginia, is a multi-racial community that is also stratified by median household income.[xviii] Faced with a failing groundwater supply for their private wells, residents were able overcome racial and economic differences to collaborate in building the infrastructure for connections to the public water service provided by the County. In the condomial system in Northeast Brazil, individual households cooperate to manage a shared sewer infrastructure.[x]

Social capacity also refers to the absence of direct institutional opposition to the community organization necessary for providing municipal sanitation services in lower-income communities. Such organization requires the participation of an active leader or group of leaders who can motivate the community to organize, plan, implement, and manage the service. Community organization for MSS also requires the dissemination of information through public meetings, pamphlets, the Press and other communications media. In many societies, institutional forces actively suppress some or all of these activities – influential community leaders, community organization for action, and community-based information dissemination. Under military rule in Brazil in the 1970s and early 1980s, the favelas - or shanty towns – of Sao Paulo Brazil, were denied and prevented from developing water service by the state water utility SABESP. With the withdrawal of military rule in the mid to late 1980s, the community organized to develop a management system and pressure SABESP to provide water service to their communities.[x]

Cultural Capacity refers to the cultural values that underlie a community's preferences for a particular type of access to the MSS. Many of the difficulties in implementing sanitation system arise from the fact that sanitation improvements are an intervention in the domestic domain. Its use requires a change in people's most private habits. For example, in cultures where there is a strong preference for privacy in matters of personal hygiene, community latrines or bath houses will not be acceptable. In cultures where waste management is determined by social class, caste or by gender, centralized facilities that do not reflect these cultural preferences will fall into disuse and disrepair.[x,xix,xx]

Service Capacity

Service capacity refers to the annual service volume supplied by the providers of a sanitation service in a designated area. In LICs, information on service providers, by type and capacity, is poor either because there is no service provider or the provider is from the informal sector and wishes to remain undocumented.[xxi] Where there are official facilities, these are assumed to operate at maximum capacity because the actual daily throughput is undocumented or unknown. Capital improvements of service facilities are irregular due to weak institutional, human resource, and financial capacity requirements. Indeed, capital improvements are often made in response to crises in service delivery. The combined effect of these factors is that cities in LICs commonly face mounting deficits between the supply of and demand for municipal sanitation services. Traditionally, supply-driven approaches predominate planning and are focused exclusively on providing infrastructure and technology to close the supply gap. In many instances, engineers and planners exclude the other capacity requirements (institutional, human resources, industrial/technical, economic/financial, environmental/natural resources, and social/cultural) as social and human sciences that are either irrelevant or outside the scope of the mathematical planning model and the engineered solution. As the phenomenon of megacities grows and the problems of deficient municipal sanitation services to the people of these cities multiply, planners have begun to consider interdisciplinary approaches to MSS planning in their search for sustained solutions.[xxii,xxiii]

Appendix 2: Options Analysis

Town X has become an important link between the industrial and tourism areas. It also serves as one of the key residential catchments for the main city and those employed by the industrial centers with as much as 84% of its land allocated to residential areas. Town X has a size of 4,397.79 hectares divided into 73 political units.

Capacity Factors

A Succinct Description of the Capacity Factors for Town X is detailed in Table 6.

Table 6
Capacity Requirements Appraisal for Town X MSW, 2002

Capacity Requirement	Assessment
Institutional	Municipal government – run. Relevant Laws: 1) Environmental protection laws 2) Solid waste code 3) Water code 4) Clean air act No active implementation and regulation.
Human/ Organizational	No professional staff. Small skilled crew for garbage truck maintenance. High unskilled labor force (mostly illiterate) for collection task and street sweeping. Some waste pickers.
Industrial	Rely on foreign imports (for garbage trucks, bins, and spare parts) and local engineering consultants.
Economic	Minor private sector participation. Some informal recycling market. No fees.
Environmental	Heavily impacted air, water, and land. No LF space.
Social/cultural	High personal hygiene, dissatisfied with no service.
Service	20% of total demand (75,792MT/yr)

Goal-Criteria Elicitation

The ad hoc committee undertook first round evaluations of alternatives. To reiterate, the ad hoc committee consisted of representatives from the different divisions of the Municipality of Town X.

The vision of Town X embodied the ultimate goal of the committee – To achieve sustainable development. This vision of Town X stated in the following passage:

> *We, under the guidance of Almighty God, and equipped with political will, envision a progressive, well developed, self-reliant, peaceful, healthy, and environment friendly city through sustained developments.*

– Vision of Town X

The capacity appraisal along with other suggestions from various stakeholders guided the criteria identification. The results are listed in Table **7**.

Table 7
List of Criteria for Town X MSW, 2002

Perspectives	Criteria
Institutional	Prohibition/ Support from laws and regulation
Human/Organizational	Job/ employment level
Industrial	Local resource mobilization
Environmental	Pollution impact Impact to wild-life habitat Impact to cultivable areas
Economic	Impact to other economic sectors (Market development) Investment cost Operational cost Impact to property values Affordability
Social	Health Impact Impact to urban poor Consensus (acceptability in community) Utilization Convenience
Service/ Inter-service	Capacity/ Capacity Expansion Potential DWS Impact WST Impact Short-term/ Long-term dimension Technical feasibility

Options Analysis

Current technologies provide for several proven methods to manage and dispose of solid waste. Town X decided to adopt the approach of a multi-tiered hierarchy of an integrated solid waste management program. Figure 2 gives an overview of current options available. These options are as follows:

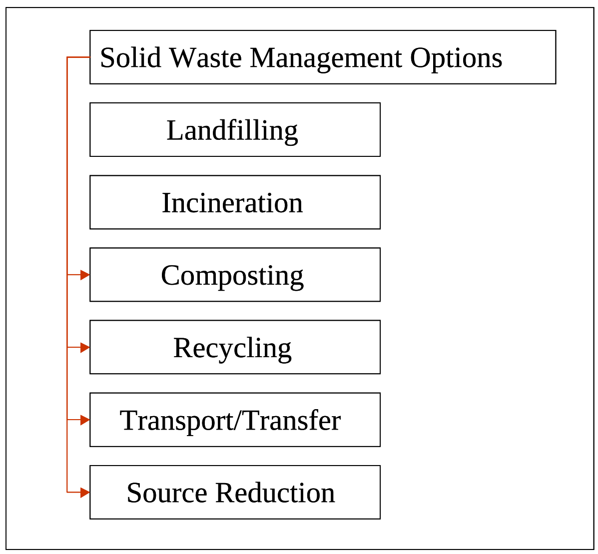

Figure 2: Alternatives for MSW

Table 8
Long-term Alternatives for Town X MSW, 2002

MSW Alternatives	Description
Landfilling	Landfilling is widely used in industrialized countries for long-term storage of solid waste. Current regulations for the design, operation, and closure of landfills fall under severe restrictions governing landfill lining systems, leachate collection and disposal, and landfill gas collection and treatment.
Incineration	Incineration is another technology widely used in industrialized countries which combust waste and on occasions produces energy. Uncertain emission risks from these facilities are currently being debated, hence the unpopularity of this technology.
Composting	Composting is the process where components of the solid waste stream is separated and then allowed through controlled natural processes, to decompose. The resultant “stabilized” materials are then utilized for land conditioning. Odor impacts and market problems are potential issues of the composting alternative. Caution is advised for co-composting of animal and plant waste, which have already failed in the US.
Recycling	Recycling has become an important program for solid waste management that has helped bring the issues of solid waste to public discussion and involvement. Four primary categories of recycling are common: commingled recovery, when recyclable and compostible materials are removed from the waste stream after collection and disposal, source separation when recyclable and compostible materials are separated prior to collection.
Transport/ Transfer	The transportation and transfer is the movement of waste and disposal to other municipality housing final disposal facilities such as landfills. The transfer of solid waste between municipalities can be a dangerous issue in the future where “not in my backyard” and “you pollute, you clean” mentalities are starting to take root.
Source Reduction	Source reduction and prevention is the practice of minimizing or avoiding discards. It can be achieved through using less material in making a product, making products more durable, making products easily repairable, or by making products easily recyclable. Reduction of waste increases the life span of disposal sites.

Table **9** lists the long-term, medium-term, and short-term alternatives considered by the Solid Waste Group of Town X. The long-term alternatives were presented to the adhoc committee for initial evaluation. The next sections illustrate the MCDM process that followed.

Table 9
Alternatives with IRP Components for Town X MSW, 2002

	Long-term	**Medium-term**	**Short-term**
Landfilling	Develop landfill	NA	NA
Incineration	Set up incineration plant	NA	NA
Composting	Set-up large-scale Composting Facility	Implement household composting	NA
Recycling	NA	Implement waste segregation program	NA
Transport/ Transfer	Purchase more garbage trucks	NA	Rehabilitate out of order garbage trucks
Source Reduction	NA	Implement source reduction program	NA

The committee convened to evaluate the alternatives in accordance with the established criteria. Consensus had to be reached as opposed to averaging scores per evaluator. Each alternative was given a nominal score (high, medium, low) for its performance with each criteria, detailed in Table **10**. The discussion method details are described in Appendix 3.

Table 10
Evaluation of Alternatives of Town X MSW by Committee, 2002

Capacity Requirement	**Criteria**	**Long-term Alternatives**			
		Landfill	*Incineration*	*Composting*	*Transfer*
Institutional	Law/ Regulation support	Medium	Low	High	Low
Environment	Pollution impact	High	High	Medium	Low
	Impact to wild-life habitat	NA	NA	NA	NA
	Impact to cultivable areas	NA	NA	NA	NA
Human	Job/ employment level	Medium	Low	High	Medium
Industrial	Local resource mobilization	Low	Low	High	Medium
Economic	Market development	Low	Low	High	Low
	Investment cost	High	High	Medium	Low
	Operational cost	Medium	High	Medium	Low
	Impact to property values	High	High	High	Low
Social	Health Impact	Medium	High	Medium	Low
	Benefits to urban poor	Low	Low	High	Low
	Consensus	NA	NA	NA	NA
	Utilization	NA	NA	NA	NA
	Convenience	High	High	Low	High
	Affordability	High	High	Medium	Low
Service/	Capacity Potential	Low	High	Medium	Low
Inter-service	DWS Impact	High	Medium	Medium	High

	WST Impact	Medium	Low	Medium	High
	Short/Long-term dimension	High	High	High	Low
	Technical feasibility	Medium	Low	High	High

Composting scored best overall (see Table **11**) for both the total and average scores, followed closely by waste transfer. Landfilling trailed in third with incineration having the lowest overall scores. The following details the performance of the alternatives per capacity requirements.

Composting scored best in the institutional requirement due to its preference by Solid Waste Code. Incineration was badly perceived since the adoption of the Clean Air Act that made the incineration of waste extremely prohibitive. Waste transfer was viewed politically unstable since it involves the jurisdiction of other municipalities for both transport and disposal. Landfilling was acceptable but only under stringent specifications, which required more documentation and paperwork in the design and development stage.

Waste transfer scored best in the environmental requirement since ultimately this involves the transfer of environmental impacts of the final sink, somewhere else. Composting scored better relatively to landfilling. Landfilling was viewed skeptically due to server land scarcity as well as its potentially negative environmental effects. Incineration was also viewed negatively environmentally, discouraged by the Clean Air Act.

Composting scored best for the human requirements since this alternative is expected to employ relatively more blue-collar workers for the manual separation tasks anticipated in the operations. Landfilling and waste transfer scored better than incineration, which was viewed to require highly skilled engineers to operate and maintain the facility.

Composting scored best for the industrial requirements. Composting is expected to use more local resources by employing waste pickers and integrating the informal recycling operators in the facility. Landfilling and incineration required imported equipment and expertise, while waste transfer sustained the status quo and so was given an acceptable score.

Waste transfer scored best the economics category. Incineration and landfilling were considered relatively more expensive from composting and waste transfer options. Although markets from crop growing and gardening activities were projected, waste transfer was perceived cheaper than composting and benign to property values since limited land is required.

Waste transfer again scored best in the social category with lesser health impact, more convenience, and still affordable. The composting alternative anticipates in the future, a rigorous source separation program at the household level. Thus, scoring low in inconvenience. Health impact for both incineration and landfilling are considered high.

For the service requirements, composting won. It has been selected as the most technically feasible due to the waste composition of Town X, having biodegradable waste as much as 66% of the total waste stream. It was felt that the current system lacks the technical capabilities to undertake incineration and landfilling technologies predominant in HICs while composting has been advocated more for LICs. Waste transfer scored poorly due to the unsustainability of the alternative for the long-term as well as dependency with other municipality's landfill capacity. Nominal scores were numerically translated, compiled, and summarized in Table 11 and Figure 3.

Table 11
Evaluation of Alternatives of Town X MSW Computations, 2002

Capacity Requirements	Criteria	High Score	Low Score	Land-fill	Incinera-tion	Compost-ing	Transfer
Institutional	Law/Regulation Support	3	1	2	1	3	1
*C_ave**				2	1	3	1
Environmental	Pollution impact Impact to wild-life habitat Impact to cultivable areas	1	3	1	1	2	3
*C_ave**				1	1	2	3
Human	Job/ employment level	3	1	2	1	3	2
*C_ave**				2	1	3	2
Industrial	Local resource mobilization	3	1	1	1	3	2
*C_ave**				1	1	3	2
Economic	Market development	3	1	1	1	3	1
	Investment cost	1	3	1	1	2	3
	Operational cost	1	3	2	1	2	3
	Impact to property values	1	3	1	1	1	3
*C_ave**				1.25	1	2	2.5
Social	Health Impact	1	3	2	1	2	3
	Benefits to urban poor Consensus Utilization	3	1	1	1	3	1
	Convenience	3	1	3	3	1	3
	Affordability	3	1	2	1	2	3
*C_ave**				2.0	1.5	2	2.5
Service/ Interservice	Capacity Potential	3	1	1	1	2	3
	DWS Impact	1	3	3	2	2	1
	WST Impact	1	3	2	3	2	1
	Short/Long-term dimension	3	1	3	3	3	1
	Technical feasibility	3	1	2	1	3	3
*C_ave**				2.2	2	2.4	1.8
			Sum	**30.0**	**24.0**	**39.0**	**37.0**
			Ave	**1.76**	**1.41**	**2.29**	**2.18**

Note: *C_ave– average score of impacts contained within the perspective category**

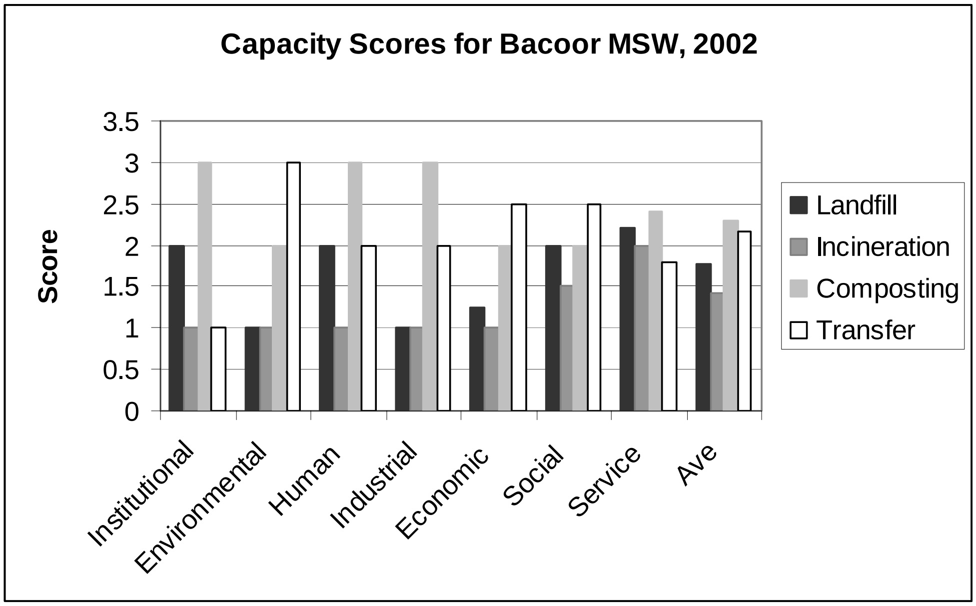

Figure 3
Category Scores for Town X MSW, 2002

Since waste transfer and composting had close scores. Further analysis of the two alternatives based on the capacity requirements was undertaken. Composting topped institutional, human, industrial, and service capacity requirements, 4 out of 7 of the capacity requirements.

Waste transfer topped environmental, social, and economic categories. However, the unsustainability of waste transfer for the long-term and reliance on another municipality made it an unpopular alternative for the committee since they were dependent on a final sink that did not guarantee continuity. And although it scored high in the environmental category, environmental costs were still being incurred by somebody else's "backyard". Economically it was simply cheapest and socially it was easiest to perpetuate the status quo.

Composting was institutionally preferred by the central Government and the Department of Natural Resources. It had the most potential to mobilize local resources, generate employment, and develop the local economy. It scored highest with service capacity offering a long-term solution, flexible capacity, and more technical feasibility for LICs. Furthermore, the committee expressed partiality to the criterions where composting scored highest namely, 1) benefit to urban poor, 2) market development potential, and 3) long-term dimension. This tipped the scale to composting, gaining heavier points for these weights.

Recommendation

In summary, a multi-tiered approach was adopted. The bulk, biodegradable waste, shall undergo composting, while recyclable materials go through recycling. This process is undertaken in a Materials Composting and Recovery Facility (MCRF). The household composting, source separation and reduction program is implemented not only to encourage sustainable waste practices but also to support the operations of the MCRF.

Waste transfer/transport operations still need to be carried out to address residual waste. This assumes that a remote final disposal site such as a landfill will be available for the residuals. The recommendation is detailed below:

I. A short-term component to increase waste-transfer capacity by rehabilitating inoperative trucks
- Rehabilitation of 3-5 trucks (rear loader/side loader) with 14-m^3 capacity for collection of additional 1,500 tpy.

II. A medium-term component to develop a household segregation and composting program
- Organization of a Community Mobilization and Environmental Education Program (CMEEP) for general environmental education and specific program information.
- Information drive concerning source separation program: compostible vs. non-compostible waste.
- Implementation of two-bin system for household, communal, and commercial waste.
- Implementation of a hierarchical collection fee system (source separated collection fee should be lower than previous standard garbage collection fee)
- Facilitation, training, and installation of household composting.
- Estimated additional capacity of 25,000 tpy.

III. A long-term component to develop a Material Composting and Recovery Facility (MCRF) for composting waste and recyclables
- Composting has been selected as the most practical alternative.
- The development of the MCRF will be housed in 5.3 hectares of land with a capacity of 43,200 tpy.

Figure 1: Land for the MCRF in Town X, January 2002

Appendix 3: Discussion Method

1. Discussion Group

In a discussion group, a small group of individuals (from five to eight) who are knowledgeable about a particular subject discuss the topic among themselves. Participants make no formal presentations; they exchange ideas through conversation.[1]

Included in the group are representatives from the following divisions of the Town X:

- Planning Division
- Health Division
- Environmental Division
- Social Works Division
- Trade and Industry Division
- MSW Group

2. Purpose

- To identify criteria for options analysis
- To evaluate options in accordance with the established criteria
- To reach a consensus in the decision-making process

3. Participant Responsibilities

- To attend multiple sessions for the MSW issue
- To participate in the activities of the discussion group
- To support the decision-making results of the discussion group

4. Procedure

A. Identify Participants

Identify suitable discussion participants and invite a small group to a meeting at an agreed place and time. The Board of Supervisors appointed the participants from the various divisions.

B. Launch the Official Opening of the Group Discussion

- Begin by introductions: invite participants to introduce themselves.
- Explain clearly the purpose of the discussion. There is no right or wrong answer but what are needed are each participant's views.
- Points, counterpoints, rebuttal, and general discussion are all appropriate. However, discussion is to deal with the main issues. All team members should be considerate and willing to discuss issues.

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[1] Hannsmann, Ralph, Scholz, Roland W., Crott, Helmut W., Mieg, Harald, A., "Education in Environmental Planning: Effects of Group Discussion, Expert Information, and Case Study Participation on Judgment Accuracy", *Natural and Social Science Interface*, Swiss Federal Institute of Technology, Zurich, November, 2001.

C. Criteria Identification
- The eight capacity requirements were presented to the participants.
- Participants were asked to write down their suggested criteria for the options analysis.
- The collected criteria from each participant were presented to all categorized by capacity requirements.
- Consensus was achieved by agreeing to employ all suggested criteria (see Table A5-12).
- The criteria identification activity took up one session.

Table A5-12
List of Criteria for Town X MSW, 2002

Perspectives	Criteria
Institutional	Prohibition/ Support from laws and regulation
Human/Organizational	Job/ employment level
Industrial	Local resource mobilization
Environmental	Pollution impact Impact to wild-life habitat Impact to cultivable areas
Economic	Impact to other economic sectors (Market development) Investment cost Operational cost Impact to property values Affordability
Social	Health Impact Impact to urban poor Consensus (acceptability in community) Utilization Convenience
Service/ Inter-service	Capacity/ Capacity Expansion Potential DWS Impact WWS Impact Short-term/ Long-term dimension Technical feasibility

D. Options Analysis
- The pre-determined alternatives were presented to the participants.
- The participants evaluated the alternatives in accordance with the established criteria. Each alternative was given a nominal score (high, medium, low) for its performance with each criteria.
- Consensus had to be reached as opposed to averaging scores per evaluator.

  Hence, prolonged discussion was necessary between participants to agree on a

  score (see Table A5-13

- Evaluation of Alternatives of Town X MSW by Committee, 2002).
- Several criterions had to be dropped because the criterion was vague, not easily evaluated, or unknown. These criterions were impact to wildlife, impact to cultivable areas, consensus (acceptability), and utilization.

- The nominal scores were translated to numerical scores and tabulated.
- The options analysis activity took up two sessions.

Table A5-13
Evaluation of Alternatives of Town X MSW by Committee, 2002

Capacity Requirement	Criteria	Long-term Alternatives			
		Landfill	*Incineration*	*Composting*	*Transfer*
Institutional	Law/ Regulation support	Medium	Low	High	Low
Environment	Pollution impact	High	High	Medium	Low
	Impact to wild-life habitat	NA	NA	NA	NA
	Impact to cultivable areas	NA	NA	NA	NA
Human	Job/ employment level	Medium	Low	High	Medium
Industrial	Local resource mobilization	Low	Low	High	Medium
Economic	Market development	Low	Low	High	Low
	Investment cost	High	High	Medium	Low
	Operational cost	Medium	High	Medium	Low
	Impact to property values	High	High	High	Low

Table A5-13
Evaluation of Alternatives of Town X MSW by Committee, 2002…continued

Capacity Requirement	Criteria	Long-term Alternatives			
		Landfill	*Incineration*	*Composting*	*Transfer*
Social	Health Impact	Medium	High	Medium	Low
	Benefits to urban poor	Low	Low	High	Low
	Consensus	NA	NA	NA	NA
	Utilization	NA	NA	NA	NA
	Convenience	High	High	Low	High
	Affordability	High	High	Medium	Low
Service/ Inter-service	Capacity Potential	Low	High	Medium	Low
	DWS Impact	High	Medium	Medium	High
	WWS Impact	Medium	Low	Medium	High
	Short/Long-term dimension	High	High	High	Low
	Technical feasibility	Medium	Low	High	High

E. Summary of Results and Conclusion

- The main purpose and objectives of the discussion group was reiterated. The results were reviewed and presented to the Board of Supervisors.

  Composting scored best for both the total and average scores, followed closely by waste transfer. Landfilling trailed in third with incineration having the lowest overall scores.

- Participants walked away feeling that they not only participated in a good learning experience, but also that they learned something about the content and about themselves as well.
- The sessions were brought to a close.

5. Materials

A range of materials including documents and pictures to introduce topics for discussion, were used. Handouts on the capacity requirements and the alternatives were given. Paper and pens were provided for the participants. A blackboard was used for presenting and discussing issues for all to see.

6. Tips on Leading a Good Discussion

- Create a safe climate. Group discussions require that leaders create a climate in which each participant feels safe and secure to voice opinions, questions and uncertainties without the threat of embarrassment or ridicule. This ensures a richer exchange of dialogue and opinion.
- Keep the conversation moving. Good discussion groups must have balance and broad participation. No one perspective or participant can be allowed to dominate the discussion, even though there may be some specific directions in which a lesson ultimately must go. Occasionally, a leader may need to prompt students who tend to sit on the sidelines to get more involved. Listening sheets, visuals, and other teaching-learning aids could help the process of discussion by adding visual support.
- Keep the discussion on topic. Chasing rabbits is one of the greatest risks of group discussions. In order to keep the discussion on track, leaders can periodically summarize the topic, clarify goals and set guidelines, such as time limits for speakers.
- Help facilitate clear communication. Good leaders help participants be better listeners, hearing the message and intent as well as the words. Good leaders may recognize that what may seem like agitation is merely a person's inability to adequately express a thought. In instances like this, the leader can help learners reshape their thoughts and help them communicate more clearly.
- Deal with group difficulties. Sometimes discussion topics may be volatile and sensitive. One participant may be very passionate and very rigid about the subject, exhibiting that he or she will not bend on a subject through verbal or nonverbal communication. Help this learner listen to and be tolerant of people who have different opinions.
- Serve as co-learner. One particular benefit of the discussion approach is that leaders can be participant as much as a teacher. Although leaders should retain control, learners have the sense of being on the same plain with the leader, a feeling that can motivate some to become more active participants.

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