Urban Solid Waste Management in Low-Income Countries of Asia How to Cope with the Garbage Crisis

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1. Introduction

Human activities create waste, and it is the way these wastes are handled, stored, collected and disposed of, which can pose risks to the environment and to public health. Where intense human activities concentrate, such as in urban centres, appropriate and safe solid waste management (SWM) are of utmost importance to allow healthy living conditions for the population. This fact has been acknowledged by most governments, however many municipalities are struggling to provide even the most basic services. Typically one to two thirds of the solid waste generated is not collected (World Resources Institute, et al., 1996). As a result, the uncollected waste, which is often also mixed with human and animal excreta, is dumped indiscriminately in the streets and in drains, so contributing to flooding, breeding of insect and rodent vectors and the spread of diseases (UNEP-IETC, 1996). Most of the municipal solid waste in low-income Asian countries which is collected is dumped on land in a more or less uncontrolled manner. Such inadequate waste disposal creates serious environmental problems that affect health of humans and animals and cause serious economic and other welfare losses. The environmental degradation caused by inadequate disposal of waste can be expressed by the contamination of surface and ground water through leachate, soil contamination through direct waste contact or leachate, air pollution by burning of wastes, spreading of diseases by different vectors like birds, insects and rodents, or uncontrolled release of methan by anaerobic decomposition of waste

Throughout the cities it is the urban poor that suffer most from the life-threatening conditions deriving from deficient SWM (Kungskulniti, 1990; Lohani, 1984), as municipal authorities tend to allocate their limited financial resources to the richer areas of higher tax yields where citizens with more political power reside. Usually, wealthy residents use part of their income to avoid direct exposure to the environmental problems close to home, and the problems are shifted away from their neighbourhood to elsewhere. Thus, although environmental problems at the household or neighbourhood level may recede in higher income areas, citywide and regional environmental degradation, due to a deficient SWM, remains or increases.

Urbanization and Urban Environmental Management

Rapid urbanization is taking place especially in low-income countries. Globally, in 1985, 41% of the world population lived in urban areas, and by 2015 the proportion is projected to rise to 60 % (Schertenleib, 1992). Of this urban population 68 % will be living in the cities of low-income and lower middle-income countries (Figure 1).

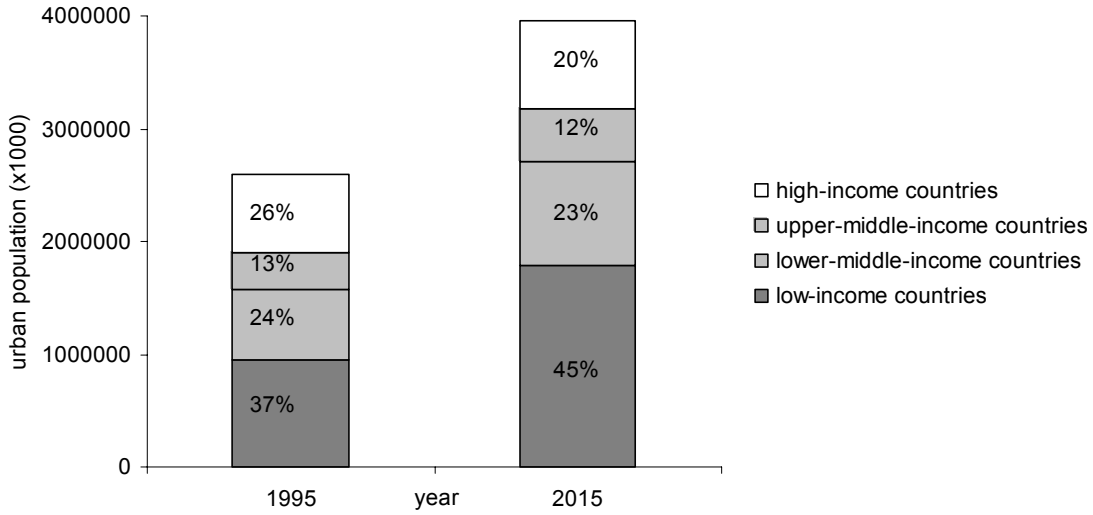

Figure 1: Global urban population categorized by of different economies (Schertenleib, 1992). Economies are divided according to 1996 GNP per capita: low income < 785 US$; low middle income 786-3115 US$; upper middle income 3116-9635 US$, and high income > 9636 US$ (http://www.worldbank.org/data/databytopic/class.htm)

An important feature often cited when dealing with the urbanization of the developing world is the rapid growth of cities and metropolitan areas. Between 1990-95 Asia's urban population has grown at an average rate of 3.2 %, compared with just 0.8 % growth in rural areas. In 1994, 9 of 14 large urban agglomerations with a population of over 10 million people were located in the Asia-Pacific region. Of the 369 cities in the world with more than 750'000 residents, 160 are in Asia and the Pacific (UNEP, 1999). Not only do these large urban agglomerations represent an enormous challenge for environmental services. The global urban data for the year 1995 (World Resources Institute, 1996) shows that approximately 65% of the urban population in the developing world still live in cities with populations smaller than 750'000. Many of these "smaller" cities are facing urban environmental management problems where appropriate approaches are sought now, before the cities' urban environments deteriorate any further. The situation is even more acute, as data shows that slums are growing at an alarming rate and as mentioned above it is especially in the urban poor areas where the municipal solid waste management service is lacking behind the needs of the inhabitants (UNEP, 1999).

2. The Elements of Asian Solid Waste Management Systems

The following chapter shall elaborate on some examples of solid waste management systems as encountered in low-income Asian countries. The description does not mean to be complete

but intends to show some typical difficulties municipalities face and elucidate what innovative solutions and approaches have been implemented.

A typical waste management system (figure 2) in a low-income Asian country can be described by the elements:

- Household waste generation and storage
- Reuse and recycling on household level (includes animal feed and composting)
- Primary waste collection and transport to transfer station or community bin
- Management of the transfer station or community bin
- Secondary collection and transport to the waste disposal site
- Waste disposal in landfills

Recovering and recycling usually takes place in all elements of the systems and is widely practiced by the informal sector "waste pickers" or by the solid waste management staff themselves for extra income. Recovered and recyclable products then enter a chain of dealers, or processing before they are finally sold to manufacturing enterprises.

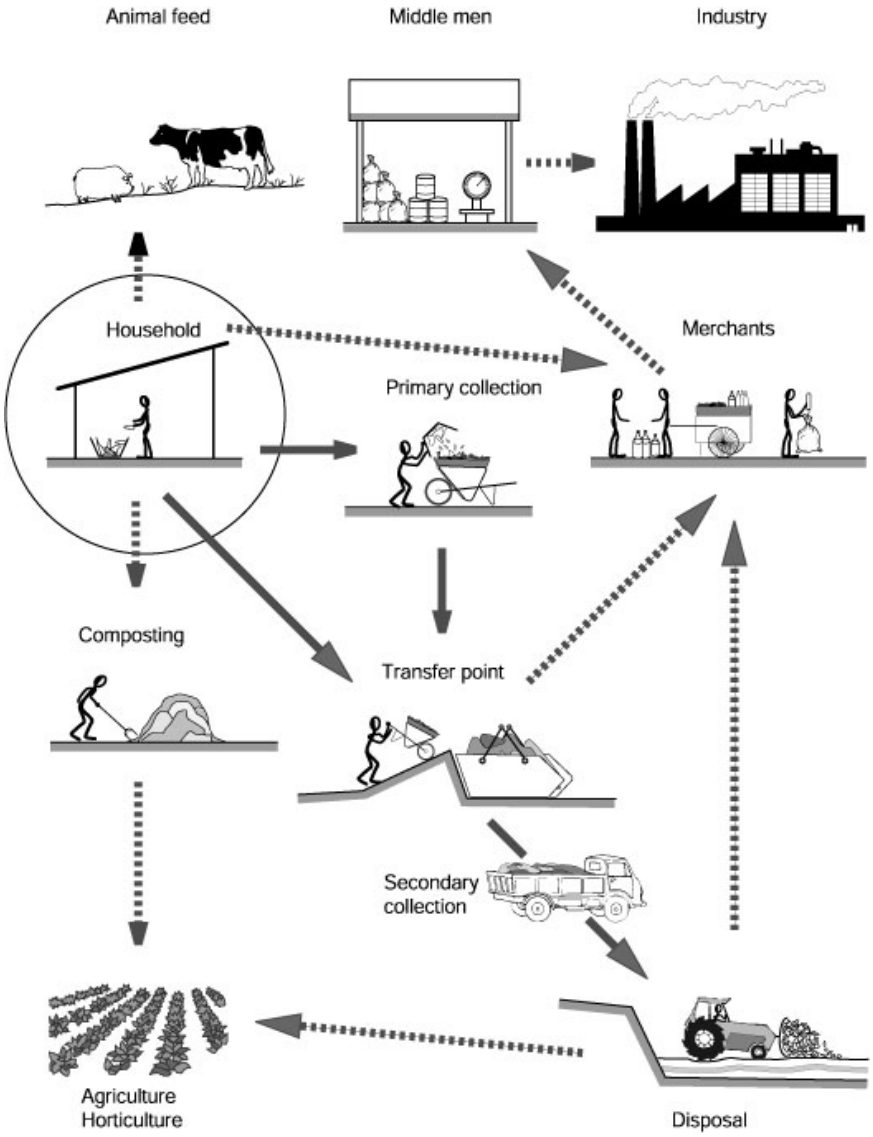

Figure 2: Typical elements of a solid waste management system in low- or middle-income countries (source: SANDEC/EAWAG)

Waste Generation

Globally the per capita amounts of municipal solid waste generated on a daily basis varies significantly. Economic standing is one primary determinant of how much solid waste a city produces (World Resources Institute, 1996). Table 1 shows waste generation rates for some Asian low- and middle income countries as cited in the literature.

Table 1: Waste generations rates of some Asian Countries, sorted by ascending Gross National Income (GNI).

Country	GNI[a]	Waste generation [kg/capita day]	Reference
Nepal	240	0.2 - 0.5	(UNEP, 2001)
Cambodia	260	1.0	(Yem, 2001)
Lao PDR	290	0.7	(Hoornweg, 1999)
Bangladesh	370	0.5	(Hoornweg, 1999)
Vietnam	390	0.55	(Hoornweg, 1999)
Pakistan	440	0.6 - 0.8	(World Wildlife Fund, 2001)
India	450	0.3 - 0.6	(Ahmed, 2000; Akolkar, 2001)
Indonesia	570	0.8 - 1.0	(Mukawi, 2001)
China	840	0.8	(Hoornweg, 1999)
Sri Lanka	850	0.2 - 0.9	(Jayatilake, 2001; Hoornweg, 1999)
Philippines	1040	0.3 - 0.7	(World Bank, 2001)
Thailand	2000	1.1	(Hoornweg, 1999)

[a] GNI 2000 per capita in $, based on Atlas Method, see http://www.worldbank.org/data/databytopic/class.htm

Although the table shows an increase of waste generation rates with higher GNI, it is important to note that the ranges given are large. In most cases this reflects the large differences between rural and urban areas. Waste generation figures cited in the literature are often not commented further and thus do not allow precise interpretation of the value. Alkohar (Akolkar, 2001) shows that waste generation rates in India vary in relation to the cities sizes. The data shows average rates of 0.21 kg/cap day for cities between 100'000-500'000 population and 0.5 kg/cap day for cities larger than 5'000'000 population. Similar figures are shown for Nepal (UNEP, 2001).

Waste Composition

Although countries sometimes use different categories for the physical characterization of solid waste, the categories listed in Table 2 can usually be distinguished in the various waste characterization studies. Not only wealth, but also consumer patterns significantly influences waste composition.

Table 2: Typical average waste characteristics in urban settings, sorted by descending biodegradable waste fraction

	Waste Categories (average percentage of wet weight)						
City	Bio-degradable	Paper	Plastic	Glass	Metal	Textiles & Leather	Inerts (ash, earth) & others
Indonesia[5]	74	10	8	2	2	2	2
Dhaka[2]	70	4.3	4.7	0.3	0.1	4.6	16
Kathmandu[1]	68.1	8.8	11.4	1.6	0.9	3.9	5.3
Bangkok[1]	53	9	19	3	1	7	8
Hanoi[1]	50.1	4.2	5.5		2.5		37.7
Manila[6]	49	19	17		6		9
India[4]	42	6	4	2	2	4	40
Karachi[3]	39	10	7	2	1	9	32

[1] (UNEP, 2001), [2] (Kazi, 1999), [3] (APE, 2001), [4] (Akolkar, 2001), [5] (Walhi, 2001), [6] (World Bank, 2001)

The high content of biodegradable matter and inert material, results in high waste density (weight to volume ratio) and high moisture content. These physical characteristics significantly influence the feasibility of certain treatment options. Vehicles and systems operating well with low-density wastes such as in industrialised countries will not be suitable or reliable under such conditions. Additionally to the extra weight, abrasiveness of the inert material such as sand and stones, and the corrosiveness caused by the high water content, may cause rapid deterioration of equipment. Wastes with a high water or inert content will have low calorific value and thus also not be suitable for incineration.

Institutions and Partnerships in SWM

In many cities of Asia, deficiencies in the provision of waste services are the result of inadequate financial resources, lacking management, and technical skills of municipalities and government authorities to deal with the rapid growth in demand for service. Although budgets are limited, the willingness to pay for well rendered services is high thus giving an opportunity for appropriate approaches.

Local authorities of Asian cities (Asia Development Bank Institute, 1998) see their main challenges as:

- unplanned growth and increasing pressure to provide services
- lack of adequate authority to address people, infrastructure and resourcing problems
- bureaucratic confusion and delays due to a multitude of agencies (local, provincial and national level) operating within the same municipal boundaries
- lacking accountability
- limited communications within the city administration and more importantly between the city administration and the various stakeholders
- political interference, as elected representatives often do not confine themselves to strategic planning, policy setting and oversight of performance, but instead become involved in daily operations
- lacking skills of municipal workforces, whereby training is often reserved to senior staff and seen as a reward for good work and seen as a chance to break away from the daily obligations

The situation in Delhi, India shows typical institutional deficiencies, faced by many urban local bodies. "In the Municipal Corporation of Delhi, there are about 46'000 workers in solid waste management. Only 33'000 are available in the field. The rest serve as domestic servants at the residences of politicians. The absentee rate is 25%. The sanitary inspector, who supervises them, knows about it but takes money from the worker and marks him as present" (Ahmed, 2000).

There is a trend, sometimes driven by failing municipal systems or by pressure from national governments and international agencies, to outsource the provision of services to the private sector. "Public Private Partnerships (PPP)" is a term used for describing a variety of relationships between public and private sector actors. In many countries private companies are interested in providing solid waste management services and such partnerships are successively implemented by the responsible authorities. In Chennai, a major port city in Southern India, the French multinational Onyx won a contract with the municipal corporation to collect the waste and sweep streets in one area of the city (Jayaraman, 2002). Remuneration per ton of waste collected is significantly lower than the previous expenses of the municipality and Onyx has won many praises from many residents for good service. An important factor in the success of private sector participation is the ability of the municipal administration to write and enforce an effective contract. The contract document must be well written to describe in quantitative terms what services are required and to specify penalties and other sanctions that will be applied in case of shortcomings. The ability and willingness of the municipality to monitor the performance of the private partner and enforce sanctions if necessary, are crucial for an effective partnership and for the long-term improvement of the cities situation.

As an alternative to large (often multinational) companies, the local private sector, micro-enterprises or small enterprises (MSEs), or even community-based organisations can also provide much of the solid waste services for a city (Pfammatter, 1996 ; Haan, 1998). The concept here is that waste management is seen as meeting citizens' needs therefore citizens are entitled to transparency in decision making; Waste management is not merely a service delivered by urban authorities but a cooperative undertaking that requires the coordination of informal behaviours and conventional management approaches. With this concept, citizens can perform some of the work, and people should assess the performance of municipal staff and have the right to raise questions about decisions on, for instance, the siting of dumps and transfer stations. Watchfulness and peer pressure of citizens is then also crucial to monitoring solid waste management activities (UNEP-IETC, 1996).

Figure 1: Primary waste collection by tricycle at a community-based scheme in Bangalore, India

Well adapted to the local conditions such small scale approaches often use simple equipment and labour-intensive methods, and therefore can collect waste in places where the conventional trucks of the municipality or large companies cannot enter (figure 1).

Typical schemes often observed in Asian cities provide primary collection service (house to house waste collection and transport to an intermediate collection point). Such primary collection, often managed by community-based organisations or small enterprises, is often initiated by the residents desperate need for a collection service for which the residents are also willing to pay monthly collection fees. A recurring problem with such small scale waste management schemes is that the waste usually needs to be handled by another entity – often the municipality – from the intermediate collection point for further transport to the far away disposal site. A solution is to recycle as much of the waste locally – with a decentralised approach - so that there is very little need for on-going transport of collected waste.

In Indonesian cities municipal governments have introduced and promoted the concept of organized citizen participation and involvement in primary collection schemes. In the city of Yogyakarta for instance, such schemes - using handcarts for house to house collection - are managed by the community or neighbourhood units and play a significant role in the city's solid waste management system (Yayasan Dian Desa, 1993). Based on such existing schemes further activities such as recycling of the organic fraction by composting have also been initiated (Zurbrugg, 1999).

After five years of operating a neighbourhood waste collection and decentralised composting scheme, the NGO Waste Concern in Dhaka, Bangladesh, has shown the great potential of community-based decentralised approaches and finally convinced Dhaka's Municipal Corporation and Public Works Department to provide government land on which they can establish more community-based composting plants (Sinha, 2000). Government agencies

control the land and projects, while Waste Concern acts as the implementing agency. Eight new community-based composting plants are being established throughout the city for a trial period of one year and depending on the success of the composting units, the time period may be extended. International donors have also recognised the potential of such approaches and are supporting the implementation of such schemes in 14 cities of Bangladesh. Waste Concern has been able to demonstrate how new approaches, in which non-governmental and private sector enterprises work together with waste management authorities, can tackle the serious problems of solid waste management.

In the city of Mumbai, India, community initiatives in solid waste management are currently being supported by the municipal authorities. One initial successful scheme initiated by a resident caught the interest of the Municipal Commissioner who wanted such schemes to be replicated in other areas of the city. To this purpose he designated an "Officer on Special Duty" to promote, and support what were then called Advanced Locality Management schemes (ALMs). ALMs are formed streetwise or small area wise and consist of community-based structures or neighbourhood initiatives. As support to these schemes the municipality provides a platform for exchange and communication for ALM representatives and municipal authorities. On one hand these are conducted on ward level with the municipal ward offices every two weeks, and on the other hand on a monthly basis together with the Additional Commissioner at the municipal headquarters. These meetings enable the residents to address their area-related problems such as waste collection, road repair, lighting, water supply or drainage problems in front of the municipal authorities. The chance to solve problems together is regarded as a very important factor for developing social cohesion in the neighbourhood. In addition, the municipality has organised 2-day workshops for each of the 6 city zones inviting various NGOs and Citizens Groups to discuss and exchange views with municipal officers. Continuous support and a proactive approach to problem solving by the Municipality is provided through a Municipal Junior Engineer assigned as "Nodal Officer" at the section level. His function is to visit and interact with the ALMs on a regular basis. In most cases, ALMs begin with an awareness and cleanup campaign. Waste collection and street sweeping is often considered the priority focus and the first step in a good working relationship between the municipal workers and the citizens. It is important to recognise that the institutionally embedded structure of the ALM system sets the framework for such further activities such as resource recovery and recycling.

Awareness and attitudes

Public awareness and attitudes to waste can affect the population's willingness to cooperate and participate in adequate waste management practices. General environmental awareness and information on health risks due to deficient solid waste management are important factors which need to be continuously communicated to all sectors of the population. Participation of the population can be by carrying waste to a shared container, by segregating waste to assist recycling activities, or even if only by paying for waste management services. Some examples of continuous education and awareness campaigns are the regular "Green and Clean" campaigns to promote environmental awareness by the Metro Manila Women Balikatan Movement and the Green Forum in Manila (UNEP-IETC, 1996). Another example is the Environmental Pioneer Brigade Programme in Sri Lanka where children are made aware of environmental problems, are shown how to manage the problems, or how to be preventative so that the problems do not occur.

Resource recovery and recycling activities

In many low-income Asian countries, recycling and recovery is usually conducted by the informal sector on all levels of the waste management stream. Such work is done in a very labour-intensive and unsafe way, and for very low incomes. The situation in industrialised countries is very different, since resource recovery is undertaken by the formal sector, driven by law and a general public concern for the environment, and often at considerable expense.

In the past the role of the informal sector in waste management has hardly been recognised by the responsible authorities. Often the municipal authorities even actively hindered such recycling activities. Now, more and more, the importance of recycling activities in reducing waste volume and recovering resources and its economic benefits is being acknowledged.

In the Philippines a growing number of local governments are implementing integrated waste management, which includes waste reduction, recycling, composting and re-use. Estimates have shown that trade in waste materials has increased in volume by 39 % (World Bank, 2001). Some key factors that affect the potential for resource recovery are the cost of the separated material, its purity, its quantity, and its location with regard to the intermediate and final processing facilities. The costs of storage and transport are major factors that decide the economic potential for resource recovery.

Composting is an excellent method of recycling biodegradable waste from an ecological point of view. However, many large and small composting schemes have failed because not enough attention was given to the marketing and the quality of the product. Current promising developments can be observed in Bangladesh where local government authorities as well as the Ministry of Agriculture is supporting and promoting composting and the use of compost in agriculture. In India, the new solid waste legislation (Ministry of Environment and Forests, 2000) obliges municipalities to introduce household segregation of organic and non-organic waste (called "wet" and "dry" waste respectively) and to treat the organic fraction by composting or other appropriate means. Composting activities are becoming more and more common as well as pilot plants for biomethanation of organic wastes, however the challenge to establish a market and demand for the compost product has yet to be tackled.

Disposal

Open dumps - unfortunately still mostly observed in developing countries - where the waste is dumped in an uncontrolled manner, can be detrimental to the urban environment. Many governments now acknowledge the dangers to the environment and to public health derived from uncontrolled waste dumping. However often officials think that uncontrolled waste disposal is the best that is possible. Financial and institutional constraints are one of the main reasons for inadequate disposal of waste, especially where local governments are weak or underfinanced and rapid population growth continues. Many governments even have great difficulties when trying to define their actual solid waste management costs, as very often no detailed cost accounting is in place. When solid waste management systems based on user fees are in place, often the fees only barely cover costs of collection and transport leaving practically no financial resources for the safe disposal of waste. Financing this part of the solid waste management cycle is made even more difficult as most people are willing to pay for the removal of the refuse from their immediate environment but then “out of sight – out of mind” are generally not concerned with its ultimate disposal.

Over the years, due to rapid urbanisation, many existing disposal sites have been encircled by settlements and housing estates. The environmental degradation associated with these dumps directly affects the population with the consequence that disposal sites are subject to growing public opposition. This, together with unavailability of land, is one of the reasons why obtaining sites for new landfills is becoming increasingly difficult. Finding a site for a new landfill far away from the urban area, may have the advantage of less public opposition. However, it also means that the site is far away from the source of waste generation thus increasing transfer costs and needing additional investments in the infrastructure of roads, hence intensifying the financial problems of the responsible authorities.

Another reason for sustaining the current disposal practices are insufficient guidelines for determining location, design and operation of new landfills, or for upgrading of old dumps. Often the only guidelines and training materials available are those from high-income countries. These are based on technological standards and practices suited to the conditions and regulations of high-income countries and do not take into account the different technical, economical, social and institutional aspects of developing countries. The responsible authorities, seeing no other solution for their disposal situation, then start searching for waste treatment methods like composting or incineration to alleviate their problems. Such treatment methods however do not eliminate the need of a disposal site.

For the responsible authorities finding an ideal site, planning and designing a new landfill is a lengthy and costly affair, often only feasible with external financial aid. In some major cities loans or grants have been used to construct sanitary landfills[1]. However, if little attention is paid to the training of a site manager and to the provision of sufficient financial and physical resources to allow a reasonable standard of operation, the sites quickly degenerate into open dumps.

Improving and "upgrading" waste dumps does not necessarily have to be difficult or expensive. It should not be regarded as an alternative to a new site, but it can significantly prolong the existing site's life span and reduce the negative environmental impact that in any case would have to be dealt with when closing the site. Upgrading does not mean converting a dump to a sanitary landfill in one step. Achieving a controlled, engineered landfill with a minimal level of environmental pollution and health risk to the public (here defined as a "sanitary" landfill), can be a step to step process depending on the financial situation of the authorities. Such a step-wise approach should be supported in standards and legislation for landfill disposal. The upgrading process can prolong the existing sites life span, giving the responsible authorities time to engage in a serious siting procedure for a new landfill. As an example of step to step improvement, the government of Malaysia formulated an action plan in 1988 on the improvement of their disposal sites. When they considered the limited financial resources and technical know-how that was available, the strategy adopted was to convert open dumping to sanitary landfills in stages (Huri bin Zulkifli, 1993).

3. Conclusions

In Asian low- and middle-income countries, municipal managers still face many common solid waste management problems. Although in some cities, successful innovative ideas and approaches have been implemented on different levels of the solid waste management system

[1] Sanitary landfills are disposal sites which are built and operated according to engineering principles in order to minimise pollution of air, water and soil, and other risks to man and animals.

(from household storage to disposal), the know-how and experience is seldom communicated and transferred to others with similar responsibilities. Rather many municipal officers go through the same trial and error phases repeating mistakes made elsewhere before. Research institutions, NGOs, and International agencies are seen as very important actors for enhancing and supporting the dissemination of "best practices". It must be recognised, however, that there is not a "package solution" for solving the solid waste problem. Although the fundamental aspects of the waste management hierarchy (figure 2) remain valid, large flexibility to use different approaches for different local situations and actively involving residents at an early stage in planning and implementation are elements which have shown to be most promising.

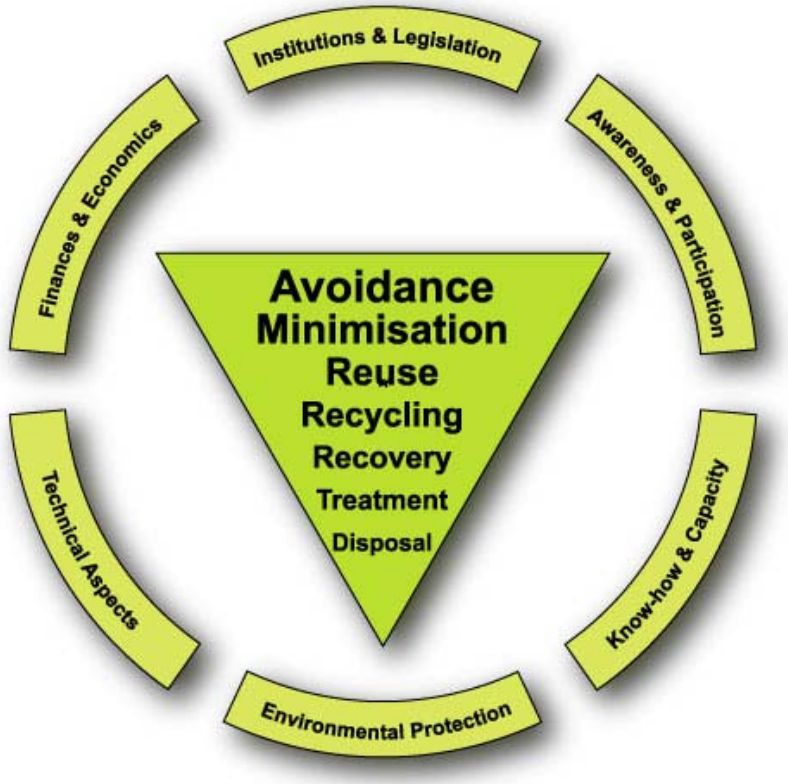

Figure 2: National and local factors (circular boxes) influencing the core concepts of the waste management hierarchy (triangle) in which priority of solid waste elements diminish from top to bottom (source: SANDEC/EAWAG).

Solid waste management is definitely not only a technical challenge. Understanding and taking into account the environmental impact, financial and economic calculations, social and cultural issues, and the institutional, political and legal framework, is most crucial for planning and operation of a sustainable solid waste management scheme.

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