CHAPTER 1:

Summary Report of 3R South Asia Expert Workshop

1. INTRODUCTION

In the Ministerial Conference on the 3R Initiative in April 2005, information sharing was identified as one of the keys for the successful implementation of the 3Rs (Reduce, Reuse, and Recycle). Also, in the Senior Officials Meeting on the 3R Initiative, it was suggested to hold a subregional policy dialogue as well as an expert group meeting on 3R-related specific issues. In this regard, the South Asia 3R expert workshop was held with the aim to: 1) discuss solid waste management issues in South Asia, 2) provide an in-depth review of selected issues related to the promotion of 3R in the region, 3) share experiences and knowledge among the countries of the subregion, 4) prepare inputs for the Asia Conference for 3R Promotion on 30 October–1 November 2006, and 5) prepare the findings for submission at the Meeting of the Environmental Ministers of South Asia, 10th Governing Council Meeting of SACEP (South Asia Co-operative Environment Programme).

For many years, major cities in Asia have experienced serious problems in waste management and disposal. In the near future, this issue will be aggravated due to continuing economic progress that will bring higher consumption and production of waste, making waste disposal problems steadily worse. The experts gathered at the 3R South Asia Expert Workshop shared their views on certain broad types of priority actions for implementing 3R programs which not only can respond to the problems of increasing waste generation, but can also gain significantly from the prospects of economic progress.

The 3R Initiative emphasizes: 1) strengthening of domestic policies, 2) reduction of trade barriers, 3) cooperation between developed and developing countries, 4) cooperation among stakeholders, and 5) promotion of science and technology. However, the participants in the Workshop found that strengthening domestic policies through collaboration among stakeholders should be a priority strategic objective for 3R promotion in South Asia. The key generic actions viewed as necessary to achieve this acceleration include:

1) Strengthening of domestic policies to implement the 3Rs, such as:

- Establishing a stable and effective national enabling policy with enabling fiscal support;
- Establishing a 3R national strategy in each country with a holistic approach covering upstream and downstream issues;
- Implementing new or improved 3R legislation that complements pollution control regulations;
- Raising the priority of waste reduction among the 3Rs above reuse and recycling, and incorporating concepts of sustainable production/cleaner production/pollution prevention into 3R strategy and programs; and
- Establishing green procurement policy as well as urgently reviewing national taxes and subsidies that discriminate against recycled products.

2) Collaboration among stakeholders, such as:

- Developing national action plans jointly among key stakeholders;
- Establishing clear targets for waste reduction and recycling for key waste sectors;
- Developing capacity of national and community governments to implement the 3Rs;
- Promoting public–private partnerships among national and regional governments, municipalities, business, and nongovernment organizations (NGOs)/civil society organizations (CSOs), and strengthening networks among them for the regional exchange of relevant experiences with technology and institutional development;
- Strengthening and protecting the informal sector in waste reuse and recycling;

- Establishing mainline and microlevel funding sources to facilitate investment and the entry of entrepreneurs into the waste management sector; and
- Mounting a campaign to change the perspective of waste management to be seen as an integral part of the manufacturing process and as an investment opportunity rather than a sunk cost.

Effective strategies and programs should be implemented at all levels to achieve the reduction, reuse, and recycling of wastes in all waste sectors. However, the workshop considered the following four sectors to be of special importance:

2. WASTE SECTORS

2.1 Domestic Solid Wastes—Principal Issues and Obstacles

To promote the 3Rs in domestic solid waste management, the participants identified that the overall priority issues are: a) establishing 3R-related policies along with environmentally sound recycling industries, b) supporting and improving informal waste recycling, and c) utilizing financial incentives and market forces. Specific issues under these categories include:

a) Establishing 3R-related policies along with environmentally sound recycling industries:

- The 3R program needs to be a formalized government policy. Recycling is market driven and must be run like an industry. Government policy is, therefore, needed to assure material quality and quantity.
- Municipal governments often lack the resources and capacity to control the uncontrolled disposal of wastes. Governments must be assisted to understand the environmental and health costs associated with uncontrolled disposal so that they will build capability and commit adequate resources to address the problem.

b) Supporting and improving informal waste recycling:

- The informal recovery of materials from wastes and the trade in these materials exist because of poverty, the low cost of labor, and the increasing demand for materials due to economic development. This activity is likely to continue to fill the gap in domestic recovery and recycling capacity in South Asia in the next 10 years. Its importance may tend to diminish as a country develops. In the meantime, governments need to take steps to improve safety, efficiency, and social sustainability in the sector.
- The informal sector is often not considered a legitimate economic sector and is poorly integrated into formal waste management programs. New business models are needed to sustain critical contributions of the informal sector while adding health and quality controls.

c) Utilizing financial incentives and market forces:

- Collection and transportation of wastes consume a major portion of municipal waste management budgets. More investment in waste reduction can be very profitable for municipalities by reducing collection and transport costs.
- There are both inadequate infrastructure and sources of financing for developing the infrastructure needed for recycling wastes. For municipal governments to make the necessary commitments, they need to understand the value of the 3Rs in financial and economic terms. The ministry of finance, city planning office, municipal service office, and ministry of environment need to come together to understand how 3Rs serves their respective interests and to plan the programs and infrastructure to implement the 3Rs.
- Tax exemptions and benefits for industry are needed to encourage them to use waste and scraps as raw materials.
- As the purchasing capacity in developing countries is low, low quality products which create a proportionately greater quantity of waste are produced. Various regulatory and economic incentive approaches can be used to increase the quality and recyclability of products.

d) Others:

- Developing countries cannot afford to build, operate, and maintain much of the technology from developed countries as it is. Technologies must be adapted to local needs and conditions.

2.2 Industrial Wastes—Principal Issues and Obstacles

The 3Rs in the industrial sector can be one of the early entry points for developing countries. Resource efficiency and the

3Rs fit well together in industrial activities. The workshop participants emphasized: a) government commitment and collaboration with industry, b) capacity development and awareness raising, c) significance of source separation and increasing resource productivity, and d) possible application of transboundary recycling.

a) Government commitment and collaboration with industry:

- There is insufficient political commitment to national programs to reduce, reuse, and recycle industrial wastes and there is a lack of national leadership institutions in the region. Government must develop its own capacity and be a leader in implementing 3R programs as an example and to provide appropriate supporting services and infrastructure. For the successful implementation of the 3Rs in industrial waste management, proper regulatory mechanisms and principles such as extended producer responsibility (EPR) should be introduced.
- Greater use should be made of appropriate tools for waste audit and for enterprise self-measurement of progress and financial gain from 3R actions. Government institutions should make serious efforts to ensure the magnitude and types of industrial wastes.

b) Capacity development and awareness promotion:

- Active regional information exchange, training, and capacity building are required to make business and public decision makers aware of current successes in 3R application. Selected pilot programs and demonstrations at a local level are needed to prove effectiveness of the 3Rs in specific local circumstances.

c) Significance of source separation:

- Allowing the mixing of small amounts of hazardous waste with nonhazardous domestic or other wastes makes all waste difficult to manage for disposal. 3R cannot function effectively without efficient separation and collection systems.
- Source separation can make possible the exchange of industrial waste and by-products from one industry as inputs for other industry through information sharing. This can be a starting point of a more comprehensive program of industrial 3Rs concerning resource productivity.

d) Transboundary recycling:

- Recycling may not be feasible on a small scale for some industrial and postconsumer hazardous wastes. Regional facilities would be useful, leading also to the need to resolve transboundary transport obstacles, harmonize national regulations, and standardize definitions of wastes.

2.3 Medical Wastes—Principal Issues and Obstacles

Medical waste management is one of the priorities for environmentally sound waste management in South Asia. Priority should be given to proper waste treatment including source separation and waste reduction rather than to reuse and recycling (such as of needles and other contaminated materials) which can pose serious human health risks. The workshop participants pointed out that the elements necessary for promoting proper management of medical wastes in the subregion include: a) national policy, regulations and guidelines for medical waste management, b) better communication among stakeholders, and c) separation of biohazardous wastes.

a) National policy, regulations, and guidelines for medical waste management:

- The establishment of national policy, regulations, and guidelines for managing medical waste is needed in most countries.
- Government and public hospitals should act as leaders and models in demonstrating safe disposal of medical waste.

b) Better communication among stakeholders:

- The establishment of better communication and sharing information about the risks from medical wastes among hospitals, other medical facilities, community and public officials would raise awareness of the issues posed by medical hazardous wastes. Public awareness of risks from medical wastes is necessary to animate government policy and public demand for proper treatment.
- The proliferation of medical clinics and other medical waste sources, many of them unregistered enterprises, has accelerated exposure to biohazardous medical wastes. These wastes pose serious human health risks if disposed in general waste dumps.

Waste pickers, including many children, are especially exposed.

c) Separation of biohazardous wastes:

- Separation of biohazardous wastes from other medical wastes is not widely practiced. Practices like color coding vary widely; thus, regional standards are needed.
- Treatment technologies are expensive and small waste polluters cannot afford the investment for their operation. Waste separation reduces the amount of waste that requires complete treatment. Shared facilities are possible but require that either government or an entrepreneur organize the operation.

2.4 E-wastes—Principal Issues and Obstacles

E-waste is one of the rising issues in the subregion due to the rapid integration of the global market. The workshop participants identified the principal issues including: a) the need for national regulations, b) transboundary movement of E-wastes, c) improper processes for E-waste dismantling and recycling, and d) technological and financial consideration in the recycling and reuse of E-waste.

a) National regulations:

- No national regulations specifically address the issues on electronic wastes in the region.

b) Transboundary movement of E-waste:

- Especially in the South Asia region, the transboundary movement of E-waste makes it essential that it be defined clearly, brought under the purview of a regulatory regime of each country and properly tracked.
- All nations in the region are signatories to the Basel Convention, which in some cases make recycling of E-wastes more difficult. There is therefore a need for harmonized codes among countries in the region to prevent illegal trade and dumping.

c) Improper processes for E-waste dismantling and recycling:

- E-waste dismantling and recycling in the informal sector intensify exposure to toxic materials through primitive processes such as acid extraction, burning, and glass breaking. Better understanding is needed of the environmental and health impacts of E-waste recycling, and both government and workers need to be better aware of the risks involved.

d) Technological and financial considerations in the recycling and reuse of E-waste.

- Technology transfer and adaptation for E-waste recycling are needed. Guidelines for proper segregation of wastes at the first level of dismantling are needed to ensure efficient downstream recycling.
- A viable financial model that integrates the informal and formal sectors is needed for the collection, transport, reuse, recycling and disposal of E-wastes.

3. PROPOSED SOLUTIONS

Each sector of waste has its own specific issues, sometimes unique to the sector in how it is resolved, but each falls into one of the three major categories as follows:

- Social/institutional—such as community involvement in recycling, organizing the informal sector in waste management, voluntary programs for reusing/recycling, awareness raising, worker protection from toxic exposure, and the role of NGOs;
- Financial/economic—such as deposit refund systems, incubation of recycling and reuse market and businesses, waste banks, taxation and subsidies, and the Clean Development Mechanism (CDM); and
- Technological/engineering—such as development of new technology to reduce or recycle wastes, adaptation of existing technology to local conditions, safe and environmentally sound waste treatment technology, new products using recycled materials, technical information dissemination and networking, and application of information technology.

3.1 Social Dimension

- In the informal sector, sweepers, waste collectors, and pickers provide important employment and handle a significant portion of municipal waste, reducing municipal collection, and disposal costs. They are generally not integrated into the mainstream economic benefit system. They need access to various benefits and support such as loans, health protection,

sorting space, social security, health care, education, and government support for their trade unions.

- Community-based recycling of household wastes is a multi-stakeholder process that can benefit the community as a whole and formalizes involvement of the informal sector while reducing demand on the municipality. This requires close consultation with community officials and real involvement with all stakeholders, economic incentives, and linkages with private business, and adequate infrastructure.
- Informal waste workers are often children, and child labor should be eliminated or reduced. Segregation of wastes at the household source can reduce the number of opportunities for waste pickers and thereby help reduce child involvement as pickers. Also, education opportunities should be provided for children in the informal waste management sector.
- Once working conditions improve and formalization proceeds, women in the informal sector are often forced out of their roles in the waste management and recycling sector. Formalizing relationships and access to micro-loans can help women maintain access to employment in the waste management and recycling sector. Experiences of other regions in microenterprises to generate employment should be examined.
- There is a high fraction of organic wastes (70–80%) in municipal waste streams in South Asia and utilization of organic wastes is therefore important. Municipalities should promote community composting or biogas generation for local income, or methane production from landfill.
- Town planning and municipal resources should be committed to provide land for composting and separation.
- With the exception of trying to reduce child labor, solutions for waste management, especially in the informal sector, should create safe and stable jobs, not reduce them.
- There are significant health hazards in handling wastes, especially medical wastes and hazardous postconsumer wastes. Source separation and proper disposal of such wastes are needed, and collaborative efforts among small producers can provide adequate disposal infrastructure. Enforcement of regulations on disposal and possibly the subsidy of infrastructure are needed to make proper disposal possible.
- Support and regulation of the informal recycling sector for E-wastes is needed to prevent dangerous small-scale recycling. Better cooperation and communication between the formal and informal sectors is needed, and buyers up the supply chain should be required to provide assistance to small recyclers to make their processes safe. An extended producer responsibility (EPR) tax can be used to help small recyclers improve safety of their processes.
- Enforcement of transboundary regulations and standardized labeling of wastes and used products can help protect recyclers in developing countries.
- Some form of environmental reporting should be required to make the community aware of the risks they incur from industrial and medical wastes. NGOs can play a key role in enforcing reporting requirements. Children reached through school programs can help make parents more aware of risks from wastes.
- Public-private partnership relationships should be developed between industry and community for better understanding of respective problems and possibilities for cooperation.

3.2 Economic and Financial Dimension

- National level policy is needed to support recycling technology (possibly subsidizing it but only in the short-run), encouraging private sector investment, and transforming the informal sector to safe and stable employment.
- Entrepreneurship in waste management should be developed and supported. Financing mechanisms are needed, such as funds to guarantee loans from local banks and to lease public land for composting and separation, and for the pilot and demonstration stages of technologies. Both domestic and foreign direct investments are needed for scaling up projects.
- Government should provide policy support for financing the entrepreneurs, research and development (R&D) from government institutions, and access to public land for composting and sorting.
- New approaches are needed for municipal waste fee structures and user charges to assure that all stakeholders in the waste management process receive financial benefit from the process. With regard to flat versus progressive fees, flat is better in the beginning, but, inspectors may violate the rules and the community must then become the inspector. The key factor is ownership, and people are willing to pay if the service is available.

- Public–private partnerships are needed to access foreign direct investment and government resources and to develop community-based organizations and the role of NGOs.
- An institutional mechanism is needed to facilitate the economic viability of source separation. A resident welfare association (RWA) which gets a commission from the collection fee makes it more efficient for the transporters than dealing with each household.
- Establish deposit refund systems on reusable items like bottle containers of beverages. Add disposal fees to the price of selected items having high disposal cost.
- Establish "green customs charges" on items which will have high disposal costs, especially used products.
- Compost and other recycling products need to be marketed through well-established commercial, private-sector marketing channels.
- With E-waste, one vendor buys waste from another, adds value, and sells it again. People may not pursue this business when the economy of the country improves, when the market fails, then policy support and market-based instruments, such as subsidies, may be needed.
- Source separation is essential and, if addressed first, will reduce the downstream costs of reuse and recycling. Government must regulate, but, may also subsidize costs of separation and proper disposal for the hazardous components of wastes.
- For the proper treatment of wastes from smaller hospitals and other biomedical sources, collective treatment or joint utilization of the treatment facilities of large hospitals can reduce the cost of treatment.

3.3 Technological Dimension

- A concerted effort must be made to change the perspective on waste management to be an integral part of the manufacturing process and to be an investment opportunity rather than a sunk cost.
- Build regional and national technology assessment capabilities, through developing regional or national knowledge hubs.
- Business can contribute to technology development through problem identification, support of pilot testing of technologies, and sharing of knowledge and experience with R&D institutions and CSOs.
- National government should provide a policy framework conducive to technology development and effective project implementation.
- R&D institutions should adapt appropriate technologies to local conditions and requirements. This can be done through funding by partner institutions and through partnerships of government with industry. Partnerships with NGOs and student exchange programs may also contribute.
- Raise the awareness of local governments to technological options for waste management and build a supporting local-level institutional framework.
- Establish national level information dissemination systems. Build pre-advisory services for entrepreneurs.
- Establish channels for exchange of information from existing users in the region. Utilize the vendors of technology as information sources.
- International institutions can provide financial and technical support to build technical capacity to manage wastes, including events and travel to provide participants with the opportunity to learn and share experience from different nations and regions.
- Regional institutions should develop networks of stakeholders within the region and initiate collaborative training and joint research for regional projects on adaptive technology development.
- CSOs can help identify local needs and options through networking with business and other civil society organizations.
- Establish local level multi-stakeholders groups for advising and monitoring local government performance.

4. STRATEGIC RECOMMENDATIONS

To better accomplish the 3Rs in the subregion, the following five points should be considered:

1. Mixing all wastes makes everything potentially more difficult and dangerous. This is especially true when medical and toxic industrial residues are mixed with garbage. Recycling and reuse of these materials become even more difficult because the materials are contaminated, losing their market value and at the same time workers are exposed to risk when separating useful items. Material separation at source could be a good immediate way to start implementing a 3R initiative.

2. Measuring wastes only by volume is not sufficient for either 3R or sustainable development as many small components mixed in the waste stream can create tremendous problems and which must be identified. The 3R strategies can be more easily implemented with better methods of waste measurement that take into account what recycled products might be produced from the waste. Measuring parameters other than volume, such as risk and the hazardousness of materials, is the key.
3. It is important to stress the fact that recycling is a production sector activity focused on selling a quality product, and not a waste business that only exists to remove inconvenient residues of small value. Only with this perspective can the concepts of quality control be introduced.
4. Recycling also produces wastes, and the disposal of these residual wastes needs to be planned. As economies develop and lifestyles change, recycling often concentrates the pollutants in a smaller volume. Consideration must be given to how to dispose of these concentrated wastes or how to recycle them a second time.
5. One must consider that small-scale recycling of hazardous industrial waste is often neither economically nor environmentally sound. Battery recycling is a case in point. We must look further into this aspect to see how to move forward.

The workshop recommends the following strategic actions toward the application of the 3Rs in the different levels of the subregion:

4.1 All Levels

- Raise the priority among the 3Rs of waste reduction above reuse and recycling and incorporate concepts of sustainable production/cleaner production/pollution prevention into 3R strategy and programs.
- Promote 3R business opportunities and entrepreneurship to establish market as well as management capacity needed for the 3Rs.
- Change the perspective of waste management to be seen as an integral part of the manufacturing process and as an investment opportunity rather than a sunk cost.
- Include agricultural biomass waste as a key sector for 3R programs.

4.2 International Level

- Ask international aid agencies to raise their priority for funding 3R programs and projects, including pilot and demonstration projects of proven technology, and not to sponsor polluting technologies.

4.3 Regional and Subregional Levels

- Establish a network of new and existing regional 3R centers of information, best practice and knowledge exchange, and technical support, such as the 3R Knowledge Hub established in Bangkok.
- Build and strengthen networks among national governments, municipalities, industry, and NGOs for the exchange of relevant experiences with technology and institutional development within the region.
- Link with existing regional networks and programs that are already working at some level of 3R—e.g., cleaner production, green productivity, eco-efficiency, etc.

4.4 National Level

- Raise the priority of 3R-related policy within national policy.
- Establish stable and effective national enabling policy with fiscal enabling support.
- Establish a 3R national strategy in each country with a holistic approach covering upstream and downstream issues.
- Implement new or improved legislation on the 3Rs that complements pollution control regulations.
- Develop national action plans jointly among key stakeholders.
- Establish clear targets for waste reduction and recycling for key waste areas.
- Establish clear guidelines for implementing 3R programs.
- Development capacity of national and community governments to implement 3R.
- Promote collaboration among municipalities, the business sector, and NGOs/CSOs.
- Promote the exchange of industrial waste and by-products from one industry as inputs for other industries through information sharing as a starting point for a more comprehensive program on industrial 3Rs.

- Establish environmental education and information services.

4.5 Local Level

- Establish 3R-related demonstration projects in key waste sectors and include waste reduction through resource efficiency.
- Involve the informal sector as a stakeholder.
- Disseminate existing success stories on the 3Rs to local agencies.
- Build public awareness of the environmental and health risks from wastes and the options for mitigation of risks through the 3Rs.

CHAPTER 2

Promoting the 3R in South Asia: Issues and Possible Solutions

2.1 Reduce, Reuse, and Recycle: The 3Rs in South Asia

C. Visvanathan and Tenzin Norbu

Environmental Engineering and Management Program
School of Environment, Resources and Development,
Asian Institute of Technology, P.O. Box 4, Klong Luang
Pathumthani 12120, Thailand
visu@ait.ac.th

1. BACKGROUND

1.1 Waste Generation in South Asia

Participants at the opening session of the World Economic Forum on East Asia held in Tokyo, Japan on 15 June 2006 were told that "the new century belongs to Asia, but at the same time, it seriously requires to tackle many challenges facing today." To which, it also includes environmental pollution, out of a few major issues. According to Japan External Trade Organization statistics, the total number of middle class in Asia is rapidly escalating. This growing number of Asia's middle class is significant in itself to reveal the emerging consumer society. These massive growths in consumer markets have in many forms, in fact, compelled the industries and responsible parties to sideline environmental issues in the name of urbanization. Unfortunately, this growth was also accompanied by a corresponding rise in solid waste generation and degradation of natural resources.

Appropriate and safe Solid Waste Management (SWM) is 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. Most of the municipal solid waste (MSW) collected in the region is dumped on land in a more or less uncontrolled manner. Such inappropriate waste disposal creates serious environmental problems that affect the health of humans and animals and cause serious economic and other welfare losses. There is also a growing concern from various international agencies that Asia may have to reassess its "growth-first" strategy, which assumes that the environment can be cleaned up once development aims are achieved. According to the World Bank's estimation, urban authorities in Asia spend 50–70% of their revenues on waste management and the effect of neglecting the environment is costing an average of 5% of GDP. As for India, it is believed to be losing as much as 5–6% of its national income for pollution control (Alan, 2002). At this crossroad of unplanned urbanization and sustainable development, the 3Rs concept (reduce, reuse, and recycle) if implemented, could be the missing piece in solving the Asian waste puzzle.

2. CURRENT PRACTICES OF 3RS IN SOUTH ASIA

It would be unfair to state that reduce, reuse, and recycle (3Rs) activities are unknown to South Asian countries and are not practiced on a regular basis. Many nongovernment organizations (NGOs) and community-based organizations (CBOs) are actively working round-the-clock in these countries—in most cases—in a decentralized manner and

often fail to fit in the bigger picture due to lack of communication, networking, and other factors. As of today, a long-standing practice and a complex networking of informal source separation and recycling of materials exists. In most cases, they were compelled to focus more on reusing and recycling of waste than on source reduction. Prioritizing the 3Rs among themselves may not promise a drastic change within a short period, but will reap a significant reward in the long run.

Recycling not only provides economic benefits, but, also offers environmental benefits by reducing reliance on virgin materials. Such programs can reduce pollution, save energy, mitigate global climate change, and reduce pressures on biodiversity. Reusing items delays or sometimes avoids that item's entry into the waste collection and disposal system. Source reduction, coupled with reuse, can help reduce waste handling and disposal costs by avoiding the cost of recycling, municipal composting, land filling, and combustion. Figure 1 shows the factors affecting the waste management hierarchy.

Similarly, recycling of wastes plays a vital part in any waste management strategy. This involves the reprocessing of waste into a usable raw material or product, thus, enabling materials to have an extended life in addition to reducing resource consumption and avoiding disposal costs. Transportation and collection of recyclable materials incurs costs thus resulting in an increased market price of such materials compared to virgin materials.

A typical waste management system in the South Asian region can be described by the following elements:

1 Waste generation and storage at the household level
2 Reuse and recycling at the household level
3 Primary waste collection and transport to community bin or transfer station
4 Management of the community bin or transfer station
5 Secondary collection and transport to the waste disposal sites/landfills

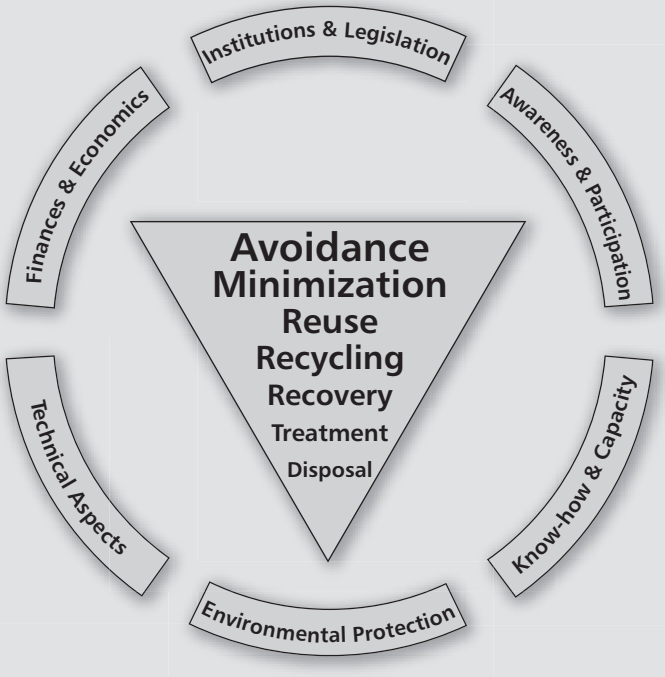
In South Asia, resource recovery and recycling usually takes place in all components of the system predominantly by the informal sector "waste pickers" or by the solid waste management staff themselves for extra income. Such work is done in a very labor-intensive and unsafe way, and for very low incomes. Recovered and recyclable products then enter a chain of dealers or processing before they are finally sold to manufacturing enterprises. The situation in industrialized countries is very different, since resource recovery is undertaken by the formal sector, driven by law and a general public concern. However, recently the importance of recycling activities in reducing waste volume, recovering resources, and its economic benefits is being acknowledged. Table 1 describes the prevailing 3R activities carried out by informal and formal sector in South Asian countries.

Most of the recyclable materials such as paper, cardboard, plastics, and metal are frequently recycled either by households or more often by rag pickers from the informal recycling sector. Though the rag pickers play a significant role in the entire process of waste management, their services go unnoticed and issues concerning their livelihood are unaddressed. Government initiatives to the needs of the waste pickers are too compartmentalized and fail to have a holistic view of their problems and requirements. It is imperative that policies be designed to incorporate them in waste management.

2.1 Informal Sectors

The existing informal sector recycling system in developing cities of South Asia essentially comprises of three groups of

Figure 1: Factors Influencing the Core Concepts of the Waste Management Hierarchy



Source: Zurbrügg, 2002

Table 1: Current 3R activities in South Asian Countries

Country	3 R practice
Afghanistan	Informal
Bangladesh	Informal
Bhutan	Informal
India	Formal + Informal
Maldives	Informal
Nepal	Informal
Pakistan	Formal + Informal
Sri Lanka	Formal + Informal

Source: AIT

actors: the waste pickers who collect recyclable wastes; the middlemen who buy, sort, and clean the recyclable wastes from the waste pickers, and small-scale enterprises who buy recyclable wastes.

Tackling solid waste issues in the developing countries could be one of the most complicated and cumbersome task. Without any formal source segregation and with minimum public participation, almost all the wastes end up in one common container or in an open backyard. Handling of such heterogenic waste becomes trickier, costlier, and beyond it, remains unattended longer. The informal sector, though very selective in their act, plays a major role in recycling papers/cardboards, plastics, metal scraps etc. They are purely dependent on the discarded refuse irrespective of its nature and toxicity. For them, the buy-back centers and the informal recycling shops are the backbone of their very survival, which in turn are market-driven and, in most cases, receive no government support.

In many Asian countries, collecting, sorting, trading, and recycling of disposed materials provide income to hundreds of thousands of people and are usually conducted by these scavengers under labor-intensive and unhygienic way. Many of these people work parallel to the formal solid waste management system; but only in an informal manner.

Informal waste separation or waste picking takes place in three ways:

1 At source — in large urban areas, e.g., commercial areas or residential areas. Here waste pickers sort out the waste before the authorized collection vehicle arrives.
2 During collection — where the collectors segregate recyclable materials during loading and store them separately.
3 At the disposal site—where the waste pickers often live or near the dumps. However, they risk the danger of potential slides and fires.

In the past the role of the informal sector in waste management has hardly been recognized by the responsible authorities. Often the municipal authorities actively hinder such recycling activities. Now the importance of recycling activities in reducing waste volume and recovering resources and its economic benefits is being acknowledged. In most countries, the extent of the formal and informal sources of separation and recycling of nonorganic wastes (manufactured materials) is significant. However, since industries would only be interested to use recycled materials when they cost less than virgin materials, the practice of recycling is so market-driven that recycling has become selective. The disposal of those unselected recyclables remains a problem.

It is estimated that about 20–30% of the waste generated in cities of Asia Pacific region, is recycled by the informal sector. In Delhi, there are about 200,000 self-employed waste pickers comprising of men, women, and children collecting about 2,000 tons (t) of rubbish daily (CSE-publications).

Karachi Metropolitan Corporation, (KMCP) Pakistan alone supports around 21,000 waste pickers or scavengers, who thrive by recycling waste paper and plastics from KMCP neighborhoods. The informal sector recycles about 1,500t/day including the material separated at source. In total there are about 90,000 waste pickers or scavengers (often Afghans in the age group of 10–25), mostly involved in waste paper and plastic scavenging-recycling sector. Recyclable items are largely separated at source where they are sold to junk dealers. There are over 400 units of recycling industrial units in the city which belong to the informal sector. According to the studies conducted by an NGO, over 5,500 households draw their livelihoods from the informal recycling industry. Under the present system, municipalities do not carry out any type of recycling activity. Normally, the main recyclable items like plastic, paper, glass, and metals are retained by the people themselves, which are later sold to street hawkers/waste dealers for recycling. As a routine scavengers make two to three trips to garbage dumps everyday and earn 100–200 Indian rupees (Rs)/per day (Also see Box 1) (URC, 2005 & Moten and Rehman, 2000).

The informal sector in Bangladesh is responsible for recycling 4–15% of the solid waste generated in different cities and urban centers. It is estimated that the informal sector has been able to save Tk 10,705.5 million (approx. $154 million) annually through such recycling (Iftekhar, E. *et.al*, 2005).

Box 1: Karachi Waste Pickers and the Recycling Industry

The waste pickers collect paper, plastic, rags, bone and metal. They put these in big plastic bags and carry them to sorting places. If the sorting point is near the Kutchra Kundi, the pickers carry the wastes physically or on bicycles. If it is far, a donkey cart or a Suzuki pick-up is hired for this purpose. Kathmandu Metropolitan City (KMC) garbage collection crews and drivers do not lift garbage from these garbage dumps regularly so as to help the pickers in their work. In return the contractor pays the KMC drivers and crew between Rs 50 to 150 per day. At the sorting point, the waste are manually sorted and packed in separate containers. The packed waste is then taken to Sher Shah Factories for primary recycling or to dealers who are also located in Sher Shah, for refined sorting. Alternatively, in a few cases, it is taken directly to factories in Korangi, New Karachi, Orangi and in Sher Shah itself for recycling or sent to recycling factories in the Punjab industrial cities.

Paper and bones are the two main items that are collected from the dumps. Others such as plastic, glass and metal are removed at home by housewives and sold to the kabaris. Paper is turned into cardboard and bones are boiled to remove grease from them. The grease is used for washing soap factories and also for soap making. The bones are ground and mixed with poultry feed. In addition to picking from dumps, pickers invade all the city markets, even in high income areas, after they close at around 7:30 pm. Here the contractors, and sometimes the pickers as well, pay the market administrators, caretakers and or shopkeepers for the waste they collect.

Source: URC, 2005

In Kathmandu, about 5% of the municipal waste, containing iron scraps, aluminum cans/plates, copper scrapes, plastic bags, and paper are recycled. The scrap dealers buy waste through scavengers and scrap collectors and sell it to recycling factories in Nepal and India. Due to lack of clean scrap plastics the recycled products are of low quality.

From a broader perspective, these amounts can be significantly increased if the MSW management systems were reengineered to incorporate and strengthen the existing informal waste recycling systems.

2.2 Involvement of Government Agencies, Private Sectors, and Organizations

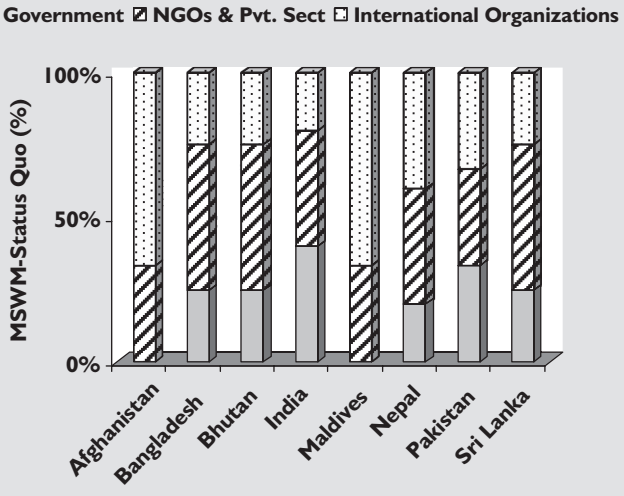
As most of the South Asian cities reel under the pressure of unplanned urban growth, waste management has taken a backseat and to go with it, the non-stringent waste policies. For decades, this joyride has taken a big toll in polluting the environment and people's mind toward environmental ethics. Often, polluters go unpunished and the consequences are borne by the poor and the innocent. In recent times, many NGOs and international organizations are footing in their resources to persuade local people and younger generations to participate in waste management campaigns, home composting and recycling of electronic waste. Figure 2 describes (subjectively) the overall involvement of government, NGOs, and international organizations toward promoting 3Rs and MSWM in South Asian Countries.

According to available sources and literature, it appears that, government agencies are less involved in overall SWM, let alone for 3Rs activities, especially in Afghanistan and Maldives. The collective efforts from NGOs, private organizations, and international organizations are worth applauding.

In both developed and developing countries, many advantages have been realized through the involvement of the private sector in the delivery of waste management services. Involving the private sector in waste management services usually results in an efficient SWM system. The private sector is usually best at providing efficiency and technical expertise, while the public sector, which is directly responsible to the people, is best at monitoring and enforcement. Therefore, a suitable combination of the best attributes of the private and the public sector will provide an efficient waste management system.

The Maharagama Pradeshiya Sabha (Sri Lanka) encouraged by the Ministry of Environment and Forest (MoEF) initiated a source segregation scheme among 2,300 households for the separation of paper, cardboard, glass, metals, plastic, and polythene. In the short time that it has been in place, it has effectively reduced the total quantity of waste collected for final disposal. The Ministry, in an attempt to replicate this success story in other Local Authorities, has distributed a newsletter among them giving guidance and encouragement to initiate such recycling practices (UNEP, 2001).

Figure 2: Government and Stakeholder Involvement in 3R and MSWM



Source: AIT

In 1998, under the West Sector Project, the Kathmandu Municipal Corporation–Nepal (KMC–N) signed a 5-year agreement with Silt Environmental Services to implement door-to-door waste collection in selected wards. The contracted service also insists the agent to introduce source separated waste collection system to promote recycling. Similarly, in mid 2002, KMCN contracted two different companies for waste management services (door-to-door collection, street sweeping, and waste transfer) under a Pilot Project. Since then, KMCN has launched Private Sector Participation to achieve efficient transfer, scrap recovery, and maximum recycling and composting (Manandhar, 2002).

In Navi Mumbai (India), a private agency has been appointed for door-to-door collection of solid waste. Besides covering large waste generators such as hotels, restaurants, and institutions; they also cover residential areas for collecting biodegradable and recyclable waste. Moreover, an NGO (Stree Mukti Sangathana) has organized about 37 women rag pickers to sort recyclable items from dumpsites thus recovering about 25t/day (Gupta, 2006).

Similarly in other parts of the South Asian countries, many NGOs are working close by with government agencies and local people to promote their participation in environmental conservation and recycling. National Forum of People's Organization in Sri Lanka provides technical support, training, disseminating information, and initiating innovative projects in partnership with others. Some of their activities are household source separation of waste, small-scale composting and biogas generation, paper recycling, networking, and information sharing (See Box 2). Also, Seth Sevana, a local enterprise, has successfully developed small-medium scale recycling of waste plastics into pellets/granules using both locally manufactured and imported machinery from India in processing HDPE, LDPE and PP (Asian Institute of Technology [AIT], 2004).

To assist the Pakistan government's officials to develop cost-effective strategies for dealing with recycling, the UNIDO National Cleaner Production Center in collaboration with the Tetra-Pak, has set up a program. The program provides awareness to the industry and community on segregation, classification, and recycling in addition to advising the government on policy approaches that are financially self-sustaining and socially and environmentally responsible.

Box 2: Waste Separation in Sri Lanka

- **National Forum of People's Organizations** has developed a pilot program for source separation targeting 500 low/middle income households at Madapatha, Piliyandala. Each participating household was required to pay Rs30 per month ($0.31) to cover the labor costs for the collection of the source-separated waste.

- **Abans Environmental Services Ltd** has been conducting a small-scale source separation of refuse collection scheme for approximately 90–100 households along three streets in a high-income area of Havelock Town, Colombo 5, since June 2000.

- **Seth Sevana** is an NGO currently undertaking a pilot project involving 1,280 families in the Moratuwa area for source separation of household wastes into different components with funding from the Community Environmental Initiatives Facility (CEIF). It hopes to extend this project in the future to cover 8,000 families generating an extra 15 tons/month of plastic waste for processing in its plastic recycling factory.

Source: AIT, 2004

The main objectives of the program are to:

1 Improve the efficiency of communities and industries in designing and implementing integrated waste recycling and management systems.

2 Build capacity of workers and community for integrated waste recycling management.

3 Create awareness among the community and planners to develop long-term plans for sustainability of the system.

Recycling Campaign 2003 was initiated to recycle post-consumer wastes and promote waste management in younger generations. This campaign was joined by UNIDO, Local Government and Rural Development, Waste Busters, Green Earth Recycling, Nestlé/CDL, and UNIDO–Pakistan. There are many actors and NGOs involved in promoting a better living environment. Box 3 presents information on a few.

Box 3: Private Actors and NGOs (Pakistan)

The Safai Kamai Bank: It operates every Tuesday from a bazaar in Karachi and uses the slogan "Garbage is Gold". People can bring their dry garbage for sale on a per kilogram basis — the price paid depends on the item. Items purchased include newspapers, other paper waste, plastic bags, metal, glass and plastic bottles.

Waste Busters: They collect rubbish from households and charge about $2 a month, which includes the delivery of about 30 rubbish bags. The refuse is taken to the transfer station where it is sorted out and loaded onto trucks for recycling.

Pakistan Environment Welfare and Waste Recycling Program (PEWWARP): It is a local NGO which has established a small production unit manufacturing three organic products from waste purchased from itinerant buyers at Karachi's huge vegetable market. This NGO collects organic waste for producing waste pellets.

Gul Bahao: This NGO has initiated a program in which common citizens are encouraged to sell their organic waste in addition to certain other waste items not collected by waste pickers.

Source: Ahmed & Zurbrugg (2002) & URC

In countries with limited involvement of private sectors and government resources, international organizations are actively assisting in managing the waste crisis. In Afghanistan, the International Centre for Science and High Technology has proposed a project to convert debris into usable building materials. The project consists of a crushing and sieving machine to transform debris for use as subgrade in the construction of roads or as a low-cost alternative building material (ICS–UNIDO).

In Maldives, UNDP has funded a project over a five-year period focusing on a range of activities to develop and implement the National Solid Waste Management Policy and remove all existing barriers. Presently, the separation and storage of different, noncombustible waste streams is practiced within the facility. However, little consideration has been given to the concept of processing or recycling these items (UNDP, 2004).

In recent years, many stakeholders in South Asian countries are undertaking waste management programs, making guidelines, identifying barriers through research projects, and organizing training programs to enhance the overall solid waste management strategy of the community. It is also equally important that these guidelines and existing barriers should be known in full detail to the policy makers in drafting appropriate and effective legislations and policies.

2.3 E-waste Recycling, 'One step forward, two steps backward'

According to Financial Express (2005), about 80% of the electronic waste or E-waste generated in the US is exported to India, the People's Republic of China (PRC), and Pakistan. This recent ban on importing E-waste to the PRC has diverted much of it to Bangladesh and other neighboring countries due to cheap labor and recycling businesses. As for India alone, the waste generated by obsolete or broken-down electronic and electrical equipment has been estimated to be 146,180 t/year based on selected EEE (Electronic and Electrical Equipment) tracer items, not including the imported WEEE (Waste from Electronic and Electrical Equipment) shipments (IRG-SSA). Neighboring countries like Sri Lanka, Nepal and Bangladesh are also not spared by this overflowing E-waste. It is a crisis not only of quantity, but, also of toxic ingredients such as lead, beryllium, mercury, cadmium, and brominated flame retardants that pose both occupational and environmental health threats. But to date, industry, government, and consumers have only taken small steps to deal with this looming problem.

Especially in developing countries, electronic waste is the highly sought-after item for scavengers and local recyclers. Table 2 describes the informal recycling of E-waste in Chennai, India.

In Delhi alone, there are about 25,000 workers employed at scrap-yards, where 10,000 to 20,000t of E-wastes are handled every year, with computers accounting for 25% (Indian Express, 2005). Figure 3 shows current scenarios about the E-waste recycling and the same practice is prevalent in most developing countries.

The informal sectors in the urban areas of developing countries are now targeting more on these WEEE issue not knowing the level of toxicity involved in their act. To recover copper and other metals, they burn the electrical components (including electrical wires) releasing deadly cocktails of toxins (Figure 4). The other accrued electronic and electric waste are dismantled and sorted manually to fractions of printed wiring boards, cathode ray tubes (CRTs), cables, plastics, metals, condensers, and other materials like batteries, LCDs, or wood.

In Pakistan, Sher Shah in Karachi is one of the principle markets for second-hand and scrap materials where all sorts of electronic and electrical spare parts, computers, and smuggled goods arrive by sea and land for sale or further distribution to other cities in Pakistan. Sher Shah serves as an open informal market, without state controls of any kind (Toxics link).

Table 2: E-waste Components in Chennai, India

Computer component	Recovered component	Mechanism employed
Monitor	Cathode ray tube, circuit board, copper, plastics	Dismantling using screw drivers (the broken CRTs are dumped)
Hard disk	PRC steel, aluminum, actuator (magnet), platter, circuit board	Broken using hammer
Circuit board	Capacitor, condenser, copper, gold, chipped board	Gold recovery — acid treatment Copper recovery — heating Crushing of boards by custom-made crushers
Printer	Motor, plastics	Dismantling using screw drivers
Cables and wires	Copper, aluminum	Burning or stripping

CRTs = cathode ray tubes; PRC = the People's Republic of China
Source: Toxics link

Figure 3: E-waste Recycling Shops in India and Pakistan — 'Man in Action'!

Source: Toxics Link

Figure 4: Burning of WEEE to Recover Precious Metals

Source: Toxics Link

2.4 Legislations and Policies

It is a very common practice in developing countries for people to dispose their waste openly or in an abandoned site, whereas they know very well they cannot enjoy this practice in many developed countries where stringent laws and policies exist. It is also not wrong to state that the not-in-my-backyard (NIMBY) syndrome might appear more when discussing solid waste issues in developing countries than in developed countries. The global coordination of SWM should focus on clearer definitions of monitoring and evaluation, particularly the use of indicators that can promote recycling and reuse of organic wastes. Suitable indicators should be incorporated in national legislation to harmonize the overall waste management activities. Environmental legislations and policies do exist in the developing countries to protect their natural resources and environment, but most of them are not revised or updated according to the need and prevailing situation. In most cases they are not clearly defined, creating complications for the implementing body, resulting in duplication of task and negligence in other activities. In cases, where they do exist, its implementation fails. The possible reasons for poor implementation could be a combination of social, technical, institutional, and financial issues. Public awareness, political will, and public participation are essential for the successful implementation of the legal provisions.

Many South Asian countries have recently made progress on the legislative front and also share common interest in tackling solid waste issues (See Box 4). Perhaps, most noteworthy is India's recent review and finalization process of the National Environmental Policy (NEP) which stresses on adoption of cleaner technology, strengthening the informal sector of collection and recycling of various materials, developing and implementing strategies for recycle, reuse, and finally, environment-friendly disposal of plastic waste.

Box 4: Dhaka Declaration 2004 on Waste Management

In 2004, delegates from the SAARC (South Asian Association for Regional Cooperation) countries — India, Pakistan, Nepal, Bhutan and Bangladesh; confirmed to put forward the recommendations from the three day intensive workshop on Solid Waste Management in Dhaka (Bangladesh). Besides other technical aspects of solid waste management, it also states that the — 'SAARC countries agree to encourage NGOs and private companies to establish community based segregation at source, separate collection and resource recovery from wastes with particular focus on composting'.

Source: Waste Concern

Recycled Plastics Manufacture and Usage Rules, 1999 was amended in 2003 and the Rules are applicable in all the States/Union Territories. It lays much stress on the manufacturing of plastics using virgin materials and recycled plastics. The Rule also details the standard size and thickness of the plastics to be manufactured. It also emphasizes the registration of the existing plastics manufacturing and recycling units with the State Pollution Control Board/Pollution Control Committee by fulfilling consent conditions (CPCB, India), also see Box 5.

Box 5: Major Developments on 3Rs in India

Nonbiodegradable Garbage (Control) Ordinance, 2006, Maharashtra, India

Nonbiodegradable Garbage (Control) Ordinance, 2006 has come into force with immediate effect, following the Governor's approval on February 27. The ordinance controls ways in which nonbiodegradable materials are to be disposed. It also bans the manufacture, transport, and use of polythene bags. Maharashtra is the third state to pass such an act. The state has set 50 microns as the least permissible thickness for polythene bags (Goa and Himachal Pradesh have specified a thickness limit of 40 microns and 70 microns, respectively). However, polythene bags used for food items, medicines, milk and oil packets are omitted from the ambit of this ban, with a specification that such bags are to be manufactured using virgin plastic raw material in its original. The ordinance makes it mandatory for polythene bags to mention the details of the manufacturers, including the registration numbers issued by the Maharashtra Pollution Control Board (MPCB). It also enjoins manufacturers to provide information on the size and quality (virgin or recycled) of polythene. Moreover, no unit is allowed to manufacture polythene bags in the state without the consent of the Directorate of Industries and Commerce and MPCB.

Source: MPCB –India

Recycling Schemes

Under the MoEF the Government of India has launched a 'Registration Scheme' to channel indigenously generated and imported recyclable waste to only those units with necessary facilities/technology to reprocess such waste in an environmentally sound manner. The ministry reported a total of 476 registered plastic reprocessing, and other 252 registered units for used oil reprocessing, lead waste reprocessing and non-ferrous reprocessing.

Charter on Corporate Responsibility for Environmental Protection (CREP)

After a series of industry specific interaction meetings, the Charter on Corporate Responsibility for Environmental Protection (CREP) was adopted in March, 2003 for 17 categories of polluting industries and is a road map for progressive improvement in environmental management. For effective implementation of the Charter, eight task forces comprising of experts and members from institutions and industry associations have been constituted. These task forces are meeting regularly to monitor and to provide guidance to the industries for adopting necessary pollution abatement measures

Source: SOM, 2006

The Indian government has also taken several initiatives in promoting recycling and cleaner technologies both at state and national levels. In addition to specific legislation with the following provisions, strict enforcement is being ensured through the state authorities (SOM, 2006):

1 A manifest system to track the waste from the point of generation to disposal;
2 A need for seeking authorization for handling of waste;
3 Registration of recyclers; and
4 Involvement and participation of the public in schemes such as the Battery dispose scheme, etc.

A new waste management system, mandated by the Nonbiodegradable Garbage (Control) Ordinance (2006), emphasizes the Municipal Corporation of Greater Mumbai (MCGM) to ensure that all housing societies, commercial complexes, and hotels maintain separate bins for biodegradable and nonbiodegradable waste and ward-level centers are set up to facilitate segregation. Violators will be fined anything between Rs5,000–Rs25,000 (approx. $100–500). But MCGM has no system in place for this mandatory waste segregation. If the ordinance has to work, a system has to be put in place (CSE-publications).

In Nepal, the roles and responsibilities of Solid Waste Management and Resource Mobilization Center (SWMRMC) are partially transferred to Kathmandu Municipality (Pokharel, 2003), and the center is now functioning under the Ministry of Local Development. The Local Self Governance Act 1999 makes local authorities responsible for the management of waste generated in their respective boundaries with special focus on public and private sector participation. This Act empowers the local authorities with the following legal powers:

- Impose a fine up to 100 Nepalese rupees (NRs) (approx. $1.4) and recur the expense to dispose the

waste or order individual or institutions to remove the waste to a safe place.
- Responsible for the maintenance of sanitary condition of the place, and launch awareness programs relating to the sanitation.
- Responsible for the management of sanitation programs including solid waste management.

In Bhutan, the current Environmental Codes of Practice for Solid Waste Management in Urban Areas was written in 2000 after numerous meetings with relevant organizations. It covers topics from waste generation to post closure of the landfill. It also mentions clearly that the Environmental Codes of Practice will be subject to review periodically and suggested improvements will be carefully considered by the National Environment Commission (NEC) and the relevant ministries, with a view to ensure that the document remains relevant and practical. It also highlights the importance of recycling and discourages informal sector involvement in handling hazardous waste in addition to tax reduction schemes for industries reusing significant amounts of waste with a minimal production of new waste. However, these codes fail to mention that violators would be punishable by law (NEC, Bhutan).

Pakistan has responded to its environmental problems by developing laws, establishing Government agencies and accepting technical assistance from donors, including the World Bank. Environmental legislation is still not well developed in Pakistan, especially in comparison to the developed world. For example, there are no national quality standards for MSW (WWF–Pakistan).

According to a UNIDO–Pakistan report, the Environmental Protection Act 1997 has not been implemented in its truest spirit. Therefore, industries are spreading pollution, even in urban areas, prohibited under the Pakistan Environmental Protection Act. Increasing population and migration into cities have created serious environmental problems including inadequate solid and liquid waste management, lack of safe water, and minimal pollution control.

Under the preamble of National Environmental Policy 2005, the government of Pakistan admits the lack of proper waste management. In NEP 2005, Under Section 3.3 (Waste management) it states that, pollution caused by liquid and solid waste in the country would be prevented and reduced. It is also states that following the approval of the policy, the Ministry of Environment would create a National Environment Policy Implementation Committee to oversee the effective implementation. The Committee would report the status of implementation to the Pakistan Environmental Protection Council. Furthermore, Provincial, District, and Tehsil Governments would also constitute Policy Implementation Committees to ensure coordinated implementation through effective participation of all stakeholders, including corporate and civil society organizations (NEP, 2005).

At the national level, in Sri Lanka, the Ministry of Forestry and Environment (MoFE) and the Central Environmental Authority are responsible for policies regarding solid waste. Important laws and regulations with regard to solid waste are cited under the National Environmental Act (NEA), the Pradeshiya Sabha Act, and the Urban Council and Municipal Council Ordinances. NEA restricts the emission of waste materials into the environment. The local government acts and ordinances state that the local authorities are responsible for proper removal of nonindustrial solid waste, and for providing suitable dumpsites. The MoFE is working on a National Strategy for Solid Waste Management, aimed at MSW. A 3-year implementation plan has already been made under which the national strategy for waste avoidance/reduction, reuse and recycling have been covered. It also encourages private sector participation in the development of infrastructure facilities for collection and transport of MSW, establishment of recycling plants at provincial/regional level and disposal with attractive financial and technical support, including adequate protection. It is also recommends that local authorities should consider privatizing the collection and disposal of wastes so as to make these activities efficient, particularly in more urbanized areas (Levien and Siriwardena, 2000 and AIT 2004). Table 3 describes the prevailing legislations and policies governing 3R issues in South Asia.

3. EMERGING TRENDS AND CONCEPTS IN SOUTH ASIA

3.1 Waste—not wasted

India: Managing Plastic waste (Central Pollution Control Board [CPCB])

It is estimated that post-consumer plastic waste constitutes approximately 4–5% by weight of Municipal Solid Waste (MSW) generated in India, compared to 6–9% in developed countries. Thermoplastics constitute about

Table 3: Legislations and Policies Governing 3R Issues in South Asian Countries

Country	Laws, Policies, and Acts
Afghanistan	No separate law for municipal solid waste (MSW)
Bangladesh	Urban Solid Management Handling Rules of Bangladesh (under preparation)
Bhutan	Environmental Codes of Practice for Solid Waste Management
India	National Environmental Policy
Maldives	No separate law for MSW and weak legislation
Nepal	Local Self Governance Act, 1999
Pakistan	No national quality standard for MSW – National Environmental Policy (NEP) 2005
Sri Lanka	National Strategy for Solid Waste Management (NSSWM)

Source: AIT

80% and thermoset approximately 20%. A newly developed machine has been in operation for recycling of plastics in an environmentally sound manner. The aim of green recycling of waste plastic was to design a system which would have zero significant adverse environmental impact. This has been achieved by assigning right motor of minimum capacity, selecting optimum L/D ratio, heat sealing, and right temperature for the processes and trapping all the emission in pollution control equipment and treating the pollutants to produce byproducts. The extrusion and pelletization processes have been redesigned to make the pollution from the process to a minimum level and, as a result, to enhance the efficiency of the process.

Another novel approach implemented was reusing plastic waste in road construction. The plastic waste (bags, cups, thermocole) made out of Polyethylene (PE), Polypropylene (PP), & Polystyrene (PS) are separated, cleaned if needed, and shredded to small pieces (passing through 4.35mm sieve). The aggregate (granite) is heated to 170°C in the Mini hot Mix Plant and the shredded plastic waste is added, it gets softened and coated over the aggregate. Immediately the hot Bitumen (160°C) is added and mixed well. As the polymer and the bitumen are in the molten state (liquid state) they get mixed and the blend is formed at surface of the aggregate. The mixture is used for laying roads. This technique is extended to Central Mixing Plant too.

As per the Indian Council for Plastics in the Environment (ICPE) the 1.2 million tons of plastics are recycled. In respect of recyclables like paper, glass, tin, etc., which are sorted at homes, 13–20% of recyclables are again sorted from MSW collected by the concerned authorities.

Managing Colombo Garbage: An Innovative Solution for Solid Waste in Sri Lanka (US–AEP)

A state-of-the-art garbage system is now turning Colombo's mountains of garbage into compost, easing the capital's disposal problem and offering hope for other cities in the country. The Burns Environmental and Technologies Ltd. (BETL) plant is the single largest MSW processing unit in the country that engages in managing sites as per international standards, for about 800–900t of refuse per day. BETL invested Rs600 million (over $5.7 million) in a facility to treat biodegradable waste and contaminants in a sustainable manner and maximize resource recovery by producing agricultural-grade compost. The public–private partnership between BETL and Colombo's Municipal Council has eased the city's garbage disposal problems and is contributing to the regeneration of Sri Lanka's coconut and tea plantations by providing high quality, low priced compost to renew agricultural land. This partnership is on its way to solving the city's MSW problems—composting 200 metric tons of MSW per day and reducing the daily amount of MSW going to the Bloemendhal site by 60%.

In Bangladesh, the recycling of MSW by composting is picking up its pace, especially after inception of many projects related to Decentralized Community-Based Composting and Barrel Type Composting (See Box 6). Efforts for recycling plastics and lead acid batteries are also picking up by employing appropriate technologies. Aside from other recent developments under solid waste management, UNICEF has initiated a project to establish Recycling Centers in 24 city corporations/municipalities as well as preparation of solid waste management plan (SAARC, 2004).

Box 6: Organic Waste Recovery and Recycling in Bangladesh

Decentralized Community Based Composting in Dhaka by Through Public-Private-Community Partnerships

In an attempt to recover the value from organic portion of waste, a research-based organization, Waste Concern, initiated a community-based decentralized composting project in Dhaka city in 1995. The prime goal of this project was to explore technical and commercial feasibility of labor intensive aerobic decentralized composting technique and to promote the principle of 4Rs (Reduce, Reuse, Recycle, and Recovery of waste) in urban areas of Bangladesh. Activities under the project included house-to-house waste collection, composting of the collected waste in a decentralized manner, and marketing of compost and recyclables.

Barrel Type Composting Project for the Urban Poor

The Barrel Type Composting model invented by the SEVANATHA, Sri Lanka inspired Waste Concern to implement the concept in the slums of Dhaka. With some modification and changes Waste Concern with the support from Local Initiatives Facility for Environment (LIFE) of UNDP launched the barrel types composting units in two slums of Dhaka. Later after successful results, this concept is being replicated in a number of slums of Dhaka as well as other cities of Bangladesh. The idea is simple; a specially designed 200 liter bottomless perforated green barrel with a lid was supplied to the slum. One green barrel is provided to a group of six households and placed on a raised base with concrete ring. The cost of each specially designed barrel along with the civil work was around TK1,800 ($30).

Source: SAARC, 2004 and Waste Concern

3.2 Cleaner Technologies and Waste Minimization Circles

In India, a scheme on adoption of clean technology and promotion and establishment of waste minimization circles in small- and medium-scale industries is being implemented. The Indian Centre for Promotion of Cleaner Technology has also been established for waste reduction treatment and disposal and to identify and exchange potential recyclable waste. Table 4 describes the recycling/reuse options adopted by the industrial sector in India (SOM, 2006).

In Pakistan, the Cleaner Production Program (CPP) has targeted the implementation of cleaner production technologies in major industrial sectors. The program aims to create well-informed constituencies of industrialists, NGOs, and technology vendors for environmental technology solutions (in terms of cleaner production options and end-of-pipe treatment systems), environmental legislation and mandates of partner institutions for CP solutions, implementation, and monitoring all over the country (See Box 7).

Table 4. Recycling/Reuse Options Adopted by the Industrial Sector in India (SOM, 2006)

Industrial solid waste	Physical state	Source	Nonenvironmental friendly option	Recycling/Reuse options
Fly ash	Powder/slurry	Coal-based thermal power station	(i) Pumped to low lying areas in form of slurry in wet system of disposal (ii) In dry method fly ash is conveyed to dumps	-Road construction -Land reclamation -Dam/earthen waste -Portland pozzolina cement -Lime fly ash bricks block sand aggregates -Cellular concrete and construction industries
Steel and Blast Furnace slag	Solid lumps (granulated/ ungranulated)	Iron and steel industries	Open dumping	-Blast furnace slag cement -As binding material -Road aggregate
Lime sludge	Slurry/paste	Fertilizer sugar and paper industries	Settling pond	-Raw material for cement manufacture -Lime-pozzolina mixture
Phospho Gypsum waste	Slurry/paste	Phosphatic fertilizer industries	Settling pond	-Manufacture of cement in place of mineral gypsum -Gypsum block board, partition panels ceiling tiles, fiber boards
Red Mud	Slurry/paste	Aluminum industries	Open dumping	- Raw mix for cement industry -Corrugated sheet, ties, building bricks manufacture -Light weight structural blocks
Press mud	Filler cake	Sugar industries	Open dumping	-Organic manure -Biogas production, effluent slurry after biogas is useful as nutrient rich bio-fertilizer
Bagasse	Solid waste	Sugar industries	Fuel	-Cellulose for pulp and paper -Cattle feed -Used in boilers as coal substitute

Source: SOM, 2006

Box 7: Cleaner Production Program (CPP)—Pakistan

Cleaner Production Program (CPP) is a Dutch-funded project, which has targeted the implementation of cleaner production technologies in major industrial sectors of Pakistan. The program aims to consolidate and replicate the successes of cleaner technologies implementation experience in Pakistan. Further to this, the program plans to disseminate the local experience to a larger audience in general and specially to the target industry sectors. The program aims to prepare major industrial sector specific environmental policies. The knowledge premises of CPP are the implementation of environmental solution packages executed directly under CPP, successful execution of environmental technology programs in different sectors of Pakistan under other projects, individual industrial unit level successful implementation of environmental solutions, and local and international researches on the subject. The Program provides the window of opportunity for systematic adoption of environmental solutions in a cost effective framework along with some pay back benefits. Savings from cleaner production options are of reasonable size and provide good justification for the implementation of full environmental solution package under long-term pay back periods. The expected results, as outputs of CPP, would support industries to comply with National Environmental Quality Standards (NEQS) and help to achieve ISO 14000 certification.

Source: CPP-Pakistan

3.3 Eco-Industrial Networking—NIA Case study

An Eco-Industrial Networking Exercise in Naroda Industrial Estate, Ahmedabad, India (UNEP.DTIE)

NIA (Naroda Industrial Estate) was the first to be created by the Gujarat Industrial Development Corporation as early in 1964. Today there are nearly 900 industries employing roughly 30,000 people. A further 40,000 people can be considered to depend indirectly on the industrial estate for their livelihood. Approximately 26% of the industries in the Estate fall into the chemicals category; predominantly dyestuff and dye-intermediates. Other types of chemical production are plastics (5%), pharmaceuticals (3%), and pesticides (1%). Engineering (24%), textile (5%), and trading companies (9%) complete the picture of significant industrial sectors within the estate. The need to enhance environmental performance beyond mere compliance has led some firms in the estate to investigate more proactive approaches, such as Cleaner Production.

A combination of environmental and economic pressures has led firms in Naroda to make process improvements so as to improve their resource efficiency, and hence, their profitability. They have achieved this mainly through a Cleaner Production approach that has helped them to enhance individual environmental performance too. This now sets the scene for them to enlarge the scope of their activities and cooperate with different companies to look for recycle, reuse, and resource recovery opportunities. A study revealed that a wide variety of wastes are being generated in the chemical industries, particularly in the manufacture of dyestuff and dye-intermediates (See Box 8).

The most important wastes generated by this industrial sector are iron sludge from the Bechamp reduction process; waste acids, in particular, sulphuric and hydrochloric acids; chemical gypsum with varying content of calcium sulphate and chlorides; sludge containing sodium chloride and sodium glycolate; and boiler ash.

Using the information on the types of waste available, opportunities for Eco-Industrial Networking within the industrial estate were explored. The study revealed that some Eco-Industrial Networking activities, or local partnerships, were already taking place in Naroda Industrial Estate. Based on these existing cases of resource recovery and the potential reuse of materials, wastes were classified into those with commercial value (C/V) and those without commercial value (NC/V). Further options to seek ways of revalorizing NC/V wastes, and look for higher (environmental and economic) value recovery options for C/V by-products or waste were analyzed.

The 20 possible partnerships identified through the study revealed a high potential for reusing, recycling or recovery of the following five materials:

1. Chemical gypsum
2. Biologically-degradable wastes
3. Mild steel scrap
4. Spent sulphuric acid
5. Iron sludge

An analysis of the process for recovering the gypsum as a raw material confirmed that it is economically viable. Gypsum generated by 19 chemical industries in the estate through neutralization of their acidic wastewater with lime has a potential use in the cement industry, subject to complying with certain specifications.

Biodegradable waste is produced by 9 companies in the estate. The total amount of waste is approximately 10,000 kg of solid material and nearly 90,000 liters of liquid waste per year. Digestion

Box 8: Overview of Wastes Generated by Naroda Industrial Estate

- Mild Steel Scrap C/V
- Cast Iron Scrap C/V
- Aluminium Scrap C/V
- Cast Iron Powder & Dust C/V
- Stainless Steel Scrap C/V
- Carbide Waste NC/V
- Rice Husk C/V
- Food Industries Waste NC/V
- Jute Waste NC/V
- Chemical Gypsum NC/V
- Iron Sludge NC/V
- Spent H2SO4 NC/V
- Spent Earth NC/V
- Soap Stock C/V
- Boiler Ash NC/V
- Hulled Sesame Seeds NC/V
- Natural Rubber NC/V
- Synthetic Rubber NC/V
- Raw Rubber NC/V
- Treated Wastewater NC/V
- HCl C/V
- Cotton Yarn Waste NC/V
- Mixed Pottery Waste NC/V
- Broken Marble Tiles NC/V
- Marble Powder NC/V
- Grey Cloth Yarn NC/V
- Polyester Waste NC/V
- Waste Paper NC/V
- Mixed Cotton Waste NC/V

C/V – commercial value; NC/V – no commercial value

of this biodegradable waste has a potential to generate biogas as an energy source for either the industrial estate or a housing development located nearby. An economic analysis has shown this energy recovery process to be extremely favorable.

While sulphuric acid is produced as a waste by 17 chemical industries, 16 engineering firms generate mild steel scrap. Both waste materials are possible raw materials to make ferrous sulphate, a chemical used in primary wastewater treatment at the Central Effluent Treatment Plant (CETP).

Other possible partnerships that have been identified in the industrial estate, include using spent sulphuric acid in the manufacture of phosphate for fertilizer; use of iron sludge to prepare synthetic red iron oxide, an alternative application for chemical gypsum in the production of plasterboard; energy conservation; and a reduction in raw material consumption, in the ceramic industries.

Reuse, recycle, and resource recovery activities have been a very useful tool to initiate an Eco-Industrial Network within the estate. The particular value of this step-wise approach has gradually encouraged the industries in the estate to focus not only on their individual environmental performance, but, also on the synergistic effects resulting from the large number of companies concentrated within the estate.

4. FUTURE PROSPECTS OF 3R ACTIVITIES AND IMPLEMENTATION

Rapid urbanization in the Asian countries (Korea, Japan, Singapore, etc.) has equally affected the South Asian counterparts. In this race toward urbanization, many developing countries have witnessed the overflowing of waste and depletion of natural resources at an alarming rate. Governments are becoming more aware of polluting sectors, and many NGOs and private organizations are raising their voices against violations. One recent example could be the failed recycling project of French Battle ship 'Clemenceau' at Alang ship yards in Gujarat, India.

It is also high time to learn from developed countries about exploiting the existing resources in a sustainable way or with minimum environmental impacts. With huge investment demands from Asia's expanding cities for infrastructure investments, it will require special attention to promote various positive practices and implement new activities. Emphasis should also be laid on developing policy and mechanisms to promote 3R activities at community and institution level and integrating locally-tailored solid waste management systems based on upstream waste minimization and sound downstream disposal, emphasizing strong community participation throughout.

4.1 Promoting Green Procurement

New government regulations in Japan and the Republic of Korea require the adoption of green procurement practices, which will serve as models for other countries in Asia and the Pacific. Japan has implemented a law concerning the promotion of procurement of eco-friendly goods and services by the state and other entities. Each ministry and agency is required to track annual purchases and report them to the Ministry of Environment. The law also requires manufacturers or service providers to provide information on the environmental impacts of items they offer for sale. Also, a Basic Policy on Green Purchasing was released in March 2004. About 45 types of eco-friendly goods and services are specified in the Basic Policy with procurement target guidelines for each.

The Republic of Korea introduced similar mandatory green procurement for 20,000 public institutions in 2005. The Green Purchasing Law adopted in December 2004 and enforced in 2005 obligated public agencies to purchase environmentally friendly products or Eco-Products. Criteria for the eco-products are set by the Ministry of Environment in addition to Purchasing Guidelines for Eco-Products. It also details public agencies to announce, practice, and report annual performances in purchasing Eco-Products. It also awards preferential grants of environment-related subsidies to local governments. To enhance and promote this novel approach, Korea Eco-Products Institute (KOECO) was established for information dissemination, capacity building, and developing criteria. The Korean Green Purchasing Network, established in 1999 and based on Green Consumer Network, also draws up purchasing guidelines, publishes eco-products catalogue, gives awards, conducts survey, etc.

The Thai Green Purchasing Network founded in 2004 under the Greening the Supply Chain Model of the Thailand Environment Institute defines concepts and definitions of Green Purchasing and Procurement and Green Product in Thailand. It also gathers information and materials related to green-products and disseminates to the public. Besides organizing information exchange forums among members and other organizations, it also provides guidelines about Green Purchasing procedure best practices (Kataoka, 2006).

4.2 Promoting Efficient and Clean Energy

There is a rapidly growing demand for the expanded use of renewable sources, increasing energy efficiency, wider application of technologies for energy production and use that can reduce both local and global environmental impacts consistent with 3R principles. Many cities are already experiencing severe shortage of sites technically and geographically suitable for landfills, and this creates greater pressure for waste reduction and application of new management and technical approaches. These include waste-to-energy and methane capture systems that may also be eligible for financing from expanding global carbon markets.

4.3 Awareness Activities—Knowledge Management

Although production and consumption are rising, awareness of citizens, corporations, and governments is still low toward waste issues. There are many stakeholders involved in working toward a recycling-based society, and all are needed to participate to overcome the sheer inertia of resistance to change. Therefore, it is important to enhance public awareness of 3R issues by coordinated action through environmental education and dissemination of information on successful inter-stakeholder partnerships.

4.4 Promoting a Circular Economy

The concept of circular economy (CE) should be promoted in the South Asian countries not only to resolve the waste issue, but, also to conserve its natural resources. Neighboring countries like Japan, PRC, and Korea are moving forward successfully in this concept. There are a number of ways to define the term circular economy. The accepted working definition may be interlinked to manufacturing and service businesses seeking the enhancement of economy and environmental performance through collaboration in managing environmental and resource issues. The theme of the CE concept is the exchange of materials where one facility's waste, including energy, water, materials—as well as information—is another facility's input. The new term that is also used widely is the 'Eco-Industrial Cluster' or Industrial Symbiosis. These activities, if exercised correctly, could prove a stepping stone toward sustainable Asian cities and possibly the best gift for our future citizens.

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2.2 Domestic Solid Waste Management in South Asian Countries: A Comparative Analysis

C. Visvanathan[1] and Ulrich Glawe[2]

[1] *Environmental Engineering and Management Program*
School of Environment, Resources, and Development –SERD
[2] *Geotechnical and Geo-environmental Engineering Program*
School of Engineering and Technology –SET
Asian Institute of Technology, P.O. Box 4, Klong Luang
Pathumthani 12120, Thailand

1. BACKGROUND

The South Asian region as a whole is experiencing rapid urban growth. Increasing population, urbanization, industrialization, and changing consumption patterns are resulting in the generation of increasing amounts of solid waste and diversification of the type of the solid waste generated. Solid waste is the most visible environmental problem among many in urban areas. Increased solid waste generation creates more environmental problems in this region, as many cities are not able to manage it due to institutional, regulatory, financial, technical, and public participation shortcomings.

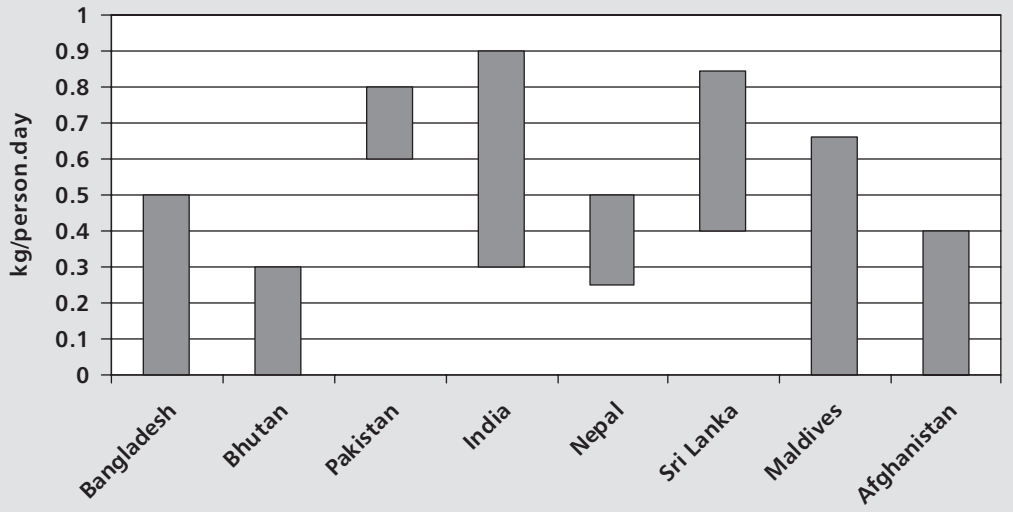
The environmental degradation caused by inadequate disposal of waste can be expressed by the contamination of surface and groundwater through leachate; soil contamination through direct waste contact or leachate; air pollution by burning of wastes; spreading of diseases by different vectors like birds, insects, and rodents; or uncontrolled release of methane by anaerobic decomposition of waste. The sustainability of the landfilling system has become a global challenge due to increased environmental concerns. Growing public opposition together with unavailability of land is one of the reasons for the increasing difficulty in obtaining sites for new landfill. Locating a landfill far away from the urban area can be adventitious from public opposition. A site that is far from the source of waste generation increases transfer costs and additional investments for the infrastructure of roads, hence intensifying the financial problems of the responsible authorities.

Common problems for municipal solid waste (MSW) management in the region include institutional deficiencies, inadequate legislation, and resource constraints. Long- and short-term plans are inadequate due to capital and human resource limitations. There is a need to practice integrated solid waste management approach, such as: incorporation of more environmental and economic friendly concepts of source separation, recovery of waste, legitimization of the informal systems, partial privatization, and public participation. Although some governments have formulated policies for environmental protection, these policies were implemented only in the national capital cities. In rural areas, open dumping is still considered the most popular method of solid waste disposal.

2. SOLID WASTE GENERATION

To prepare a well-planned waste management system, it is essential to know the quantity of waste generated as well as different categories of the waste. Solid waste generation differs from place to place to a great extent; its production and composition are influenced by consumption pattern, climate, season, cultural practice, etc. Figure 1 shows the comparison of solid waste generated per-capita (kg/day) in different South Asian countries (Zurbrügg, 2002; United Nations Environment Programme (UNEP) 2001a; World Wildlife Fund (WWF)–Pakistan 2001; Asian Institute of Technology (AIT) 2004; UNEP 2001b; UNEP 2002; UNEP 2003). Per capita waste generation is observed to vary in a range from 0.3 to 0.9 kilograms (kg)/person/day.

Figure 1: Per Capita Solid Waste Generation in South Asian Countries



Sources: Zurbrügg, UNEP, WWF-Pakistan, and AIT

Although South Asian countries and their urban areas have lower per capita waste generation rate compared to the cities of the developing countries, their quantum of waste is high owing to their higher levels of population density. According to the latest UNEP report (2005), the MSW generation in East Asia and Pacific regions has been increasing at a rate of 3–7% per year (as a result of population growth, changing consumption patterns, and expansion of trade and industry in urban centers); a similar trend has been seen in South Asian countries.

In general, solid waste generation and its composition in the developing Asian countries vary widely due to different cultural practices, living standards, and climatic conditions (AIT, 2004). Thimpu (Bhutan) generates about 10 tons (t)/day (UNEP 2001a) and Dhaka (Bangladesh) generates as high as 4,364t of waste daily (Iftekhar *et al*., 2005). Average daily solid waste generation in Kabul City (Afghanistan) is 1,080t, out of which only 250t is collected (UNEP 2003). In New Delhi (India), 3,880t of solid waste is generated each day, of which only 2,420t is collected for disposal (UNEP 2001c). In Karachi (Pakistan), around 7,000t of mixed garbage is generated daily and its generation rate is increasing by 2.4% per year (WWF-Pakistan, 2001). In Kathmandu Metropolitan City, Nepal, daily garbage flow is 944 cubic meters (m^3), approximately 300t (Manandhar, 2002), whereas in Colombo (Sri Lanka), MSW generation is 2,927 t/day (AIT 2004).

3. SOLID WASTE COMPOSITION

The composition of the waste, in general, differs from country to country—on the economic level of countries as well as other factors such as geographical location, energy resources, climate, living standards, and cultural habits. Most developing Asian countries have high percentage (50–80%) of organic matter in their waste stream with high moisture content, making them unsuitable for incineration (AIT, 2004). Compositions of MSW in some South Asian countries/cities are presented in Figure 2 (Zurbrügg, 2002; UNEP 2001c), which also reflects the heterogeneity of the waste stream. Over the years, many plastics and paper wastes had found their way into the municipal waste stream due to the rapid economic expansion.

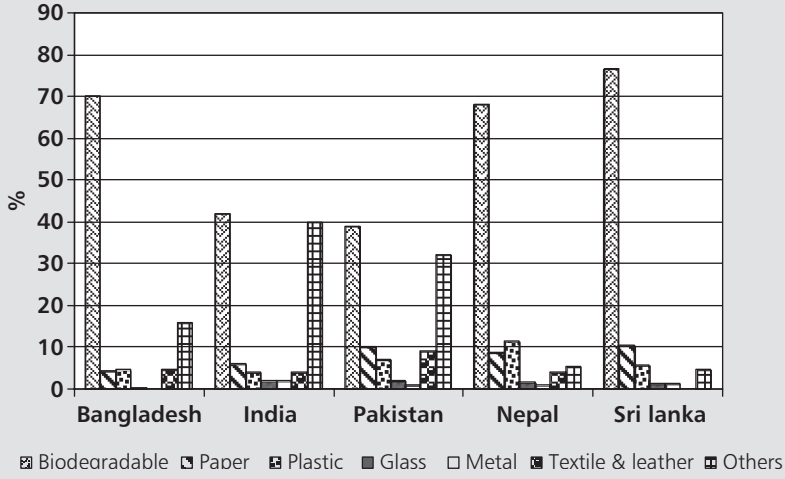
4. SOLID WASTE MANAGEMENT

Capital cities of almost all South Asian countries are challenged by urbanization and industrialization trends, population increase, and consequent rise in waste. These cities, therefore, face major problems relating to public health and environmental pollution. Poor government policy and response, lack of political will, lack of appropriate economic and human resources, and weak local institutions result in poor waste management (especially in large cities). Although municipalities are increasingly involved in managing solid waste, lack of resources and institutional and infrastructure facilities are hindering the efforts. Box 1 describes the existing status of solid waste management conducted in Indian Metro cities and state capitals after the inception of Municipal Solid Wastes (Management and Handling) Rules.

4.1 Collection and Transport

A significant amount of the solid waste generated in urban centers of South Asian countries are not collected/attended and either burned openly in the streets or end up in rivers, creeks, marshy areas, and empty lots thereby posing a serious threat to public health. In developing countries, municipal solid waste management costs consume 20–50%

Figure 2: Composition of MSW in South Asian Countries



Source: Zurbrügg, 2002; UNEP 2001c

The collection rate varies from city to city and sometimes within different sections of one urban area. The collection rate varies from 10–90 % of the total municipal waste generated. Collection facilities are either inadequate or inefficient in almost all cities. In low income or squatter settlements, garbage collection is often nonexistence as these settlements fall outside official service areas (UNEP 2001c). Figure 3 depicts the collection efficiency of various capital cities in South Asia (UNEP 2003; Department of Energy (DoE) 2004; UNEP 2001a; AIT 2004; UNEP 2001b; WWF-Pakistan 2001).

of municipal revenues, collection service levels remain low with only 50–70 % of residents receiving service and most disposal being unsafe (Cointreau, 1994). For instance, Kathmandu spends 38% of the municipal budget on MSW management; 93% of this is spent on sweeping, collection, transfer, and transport (Glawe *et al*., 2005).

Box 1: Solid Waste Management Indian Metro Cities and State Capitals

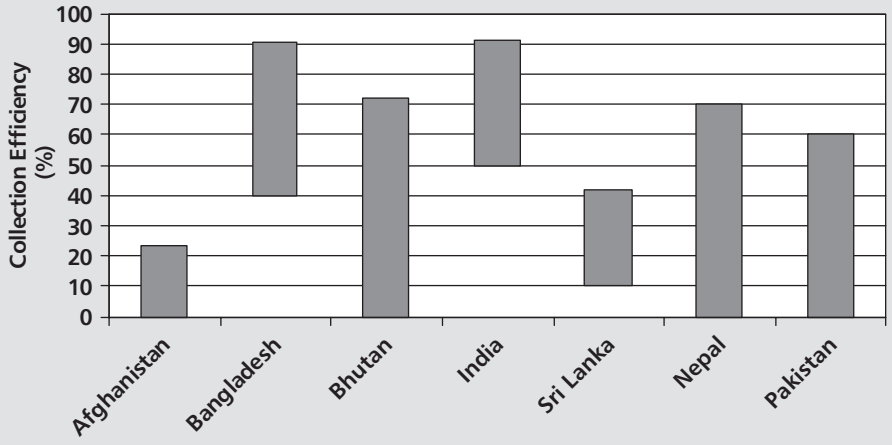
The Central Pollution Control Board, in collaboration with National Environmental Engineering Research Institute in Nagpur, has undertaken a detailed survey of 59 cities in the country to assess the existing status of solid waste management in these cities. The survey's objective was to assess the compliance status of 59 cities with Municipal Solid Wastes (Management and Handling) Rules, 2000, and initiatives taken for improving solid waste management practices. The 59 cities selected for study cover 35 metro cities. It has been observed that initiatives for collection of waste from house-to-house and waste segregation have been undertaken in only 7 cities, privatization of transportation of waste have been done in 11 cities, and waste processing facilities have been set up in 15 cities. Ten waste processing facilities are based on composting; one of these composting facilities has provision for energy recovery also, four are based on vermin-compositing, and one facility employs pelletization and energy recovery technology.

Source: MoEF – India

4.2 Processing and Disposal of MSW

According to AIT (2004), final disposal in most economically developing countries is usually a matter of transporting the collected waste to the nearest available open space and discharging them. Open dumping is predominant except for the developed countries. Composting is not carried out to the capacity that can be achieved though almost half of the MSW can be reduced thus. Other forms of disposal like animal feeding, ploughing into soil, open burning, and dumping in water bodies or wetlands contribute to environmental hazards. Waste burning is practiced to reduce its volume and minimize the attraction of animals and vermin. Despite the degradation of valuable land resources and the creation of long-term environmental and human health problems, uncontrolled disposal systems are still prevalent in most developing countries (International Solid Waste Association and UNEP 2002). Sanitary landfilling or engineered landfilling of MSW is often misinterpreted in the developing countries, especially when it comes to covering a dumpsite by soil. Financial and institutional constraints are two of the main reasons for inadequate waste disposal. Introduction of solid waste management (SWM) user fees cover only the collection and transportation costs leaving practically no resources for safe disposal of the waste. Generally, when aesthetic values are in question, most people are willing to pay for the removal of refuse from their immediate environment, but, are not concerned with its ultimate disposal. Figure 4 reflects the disposal methods of municipal solid waste practiced before 2000 in some South Asian countries. Significant changes have been made over the past few years, especially in composting organic wastes in countries like Bangladesh, Sri Lanka, and India.

Figure 3: Comparison of Collection Efficiencies



Source: UNEP 2003; Department of Energy (DoE) 2004; UNEP 2001a; AIT 2004; UNEP 2001b; WWF-Pakistan 2001

4.2.1 Open Dumping

In most cities of South Asia, open dumping is the most preferred method for the final disposal of solid waste. Though government and municipalities are already working to develop the sanitary landfill sites in few urban areas, open dumping still remains the cheapest and most effective solution to get rid of the mounting garbage. New sanitary landfill is often too distantly located compared to the open dumpsites within municipal limits. The sites far from the source of waste generation increase transfer costs and additional investments for the infrastructure of roads, hence intensifying the financial problems of the responsible authorities making the longer collection and hauling time. These open dumpsites in the course of time (Figure 5) become haven for scavengers (animals and man alike).

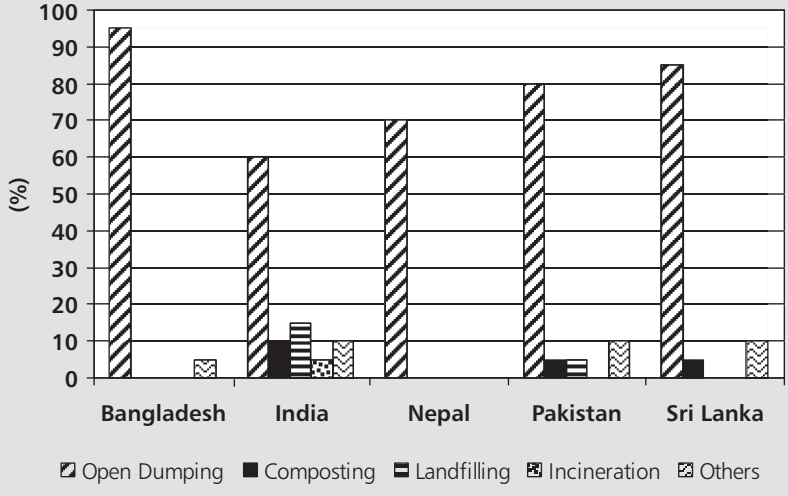
4.2.2 Composting and Recycling

Composting is the second preferred method of solid waste, mainly due to the high percentage of organic material in the waste composition. Some small-scale composting plants, such as windrow composting, in Dhaka have shown more success. However, composting at bigger scale is not that popular in the whole region. Centralized composting plants are not functioning effectively because of high operating and maintenance costs, incomplete separation, and lack of effective marketing, among others.

Increased urbanization, lack of space, and a cultural shift toward disposable plastics have all decreased household waste segregation. Many municipalities in India are experimenting with educational campaigns and hiring workers to conduct door-to-door collection of segregated recyclables (Damodaran, 2003). In many islands of the Maldives, organic wastes are composted at home backyards and nonbiodegradable waste (such as plastics) is dumped near the beach or buried in a few islands. Burning of combustible waste at designated areas is also widely practiced. The typically used method for final disposal, the overall condition of landfill is still unsatisfactory.

Informal sector "waste pickers" or solid waste management staff themselves widely practice recycling for extra income. Collection of recyclable waste is done in several steps such as households (door-to-door collection), transfer stations, and even in the disposal sites. Such work is done in a very labor-intensive and unsafe way, and for very low incomes. Recovered and recyclable products then enter a chain of dealers or processing before they are finally sold to manufacturing enterprises. The main items that are recycled include soft and hard plastics, glass, steel, paper, cardboard,

Figure 4: Municipal Solid Waste Disposal Methods Practiced in Some South Asian Countries



Source: UN 2000

Figure 5: Open Dumpsites

Sri Lanka (AIT 2004)

India (AIT 2004)

Bangladesh (Waste concern)

Pakistan (Urban Resource Centre)

aluminum, alloys, etc. In Bhutan, around 20% of the collected waste is sent for recycling. Whereas, most of the recyclable wastes collected in Nepal and Bhutan are sent to India, due to insufficient recycling factories in the countries.

4.3 Waste Management and 3R concept

In South Asian countries, the promotion of the 3Rs in the domestic solid waste management overemphasizes "recycle and reuse," and less focus is given to "Reduction." It is also interesting to note that due to the low purchasing capacity in the developing countries, the market is overflowing with low quality and cheap products creating more waste after its short useful life.

Prior to formalizing the 3R concept in the waste management hierarchy, some financial and economic issues need to be addressed and resolved:

- Is there any budget allocated for 3R activities such as awareness, motivation, etc.?
- How can 3Rs be used to meet the budget and expenditure of local governments?
- How can 3R financing and environmental benefits be linked?

As for Japan, 3R activities are promoted under the concept of "Sound Material-Cycle Society." Both treatment and 3R technology are well-developed and implemented as part of the solid waste management program. Several cities and towns get together and constitute one wide area over which an efficient 3R system is planned and implemented. An integrated system with various facilities for the 3Rs, such as biomass utilization, recycling, waste power plants, asbestos treatment and so on, are formulated under close collaboration among cities and towns.

5. LEGAL, SOCIAL, AND FINANCIAL ISSUES

Due to the similarity in economical and infrastructural development, South Asian countries are facing more or less similar legal, social, and financial problems in terms of solid waste management. Considering the necessity of environmental issues in the country's development, government and municipalities are working hard to extend environmental legislation. Table 1 presents the responsible organizations for the management of solid waste and the current situation of legislation in South Asian countries.

Public awareness and participation are a major step in effectively implementing the solid waste management system. Therefore, cooperation from the citizens is a vital

Table 1: Responsible Organization and Current Situation of MSW in South Asian Countries

Country	Responsible Organization	Current Situation
Afghanistan	Ministry of Irrigation, Water Resources and Environment, and Afghan Assistance Coordination Authority	No environmental legislation Started to develop legislation since 2000
Bangladesh	Ministry of Environment and Forest	No separate policy or handing rules for solid waste Preparing a comprehensive solid waste management handling rules
Bhutan	Municipalities	Fails to enforce the law
India	Municipal governments	Municipal Solid Waste (Management and Handling) Rules, 2000 Nonbiodegradable Garbage (Control) Ordinance, 2006
Maldives	Ministry of Home Affairs	–
Nepal	Municipalities	Local Self Governance Act, 1999 (Fails to implement national policy, improving waste management facilities, and educating people)
Pakistan	City government and town municipal administration	National Environmental Policy (NEP), 2005
Sri Lanka	Local Authorities	National Strategy for Solid Waste Management (NSSWM)

– = not available; MSW = municipal solid waste
Source: Author

aspect in managing the solid wastes of a city. Habits and attitudes of inhabitants of a city largely affect the waste management system; hence, the social aspect cannot be separated from the overall waste management system. Therefore, environmental education from schools to develop the awareness of the general public becomes important.

Financial issues are the main problem for the developing countries to carry out any kind of development programs. International organizations and donors such as the United Nations Development Programme (UNDP), Asian Development Bank (ADB), Japan International Cooperation Agency (JICA), the Government of Germany, etc. are helping the local governments establish an environmentally sustainable solid waste collection and disposal system.

6. ROLE OF STAKEHOLDERS

To achieve sustainability in waste management, it is important to look at the roles, interests, and power structures prevalent in waste management. Experience in several countries has shown that cooperation and coordination between the different stakeholder groups like city council, provincial government, service users, nongovernment organizations (NGOs), community-based organizations (CBOs), the private sector (formal and informal), and donor agencies, will ultimately lead to increase sustainability of the waste management system, such as changes in behavior and sharing of financial responsibilities. On the other hand, ignoring certain activities or groups will result in decreased sustainability of the system, for example, in the form of negative public health effects or increased unemployment (Nyachhyon, 2004).

6.1 Community-based organizations

The CBO is an essential element in ensuring the effectiveness of the solid waste management project in developing countries and increasing the likelihood of its sustainability. One such example of a successful scheme is the community-based pilot project in solid waste management in Khulna City in Bangladesh (Water and Sanitation Program – South Asia [WSP-SA] 2000). Interestingly, in most of the South Asian countries, woman plays an important role in many CBOs (See Box 2). They are responsible for keeping the house and its immediate environment clean. The women have their hands in the MSWM from household management to administrative works. They have shown active participation in various MSWM concerns including educational activities and workshops besides playing an important role in their own community.

Box 2: Women CBO in Sri Lanka

Initiated by Arthacharya Foundation in Galle and Hikkaduwa, the women community-based organization (CBO) program was based on the introduction of source separation scheme involving sorting of recyclable materials into four categories: plastics/polythene, paper/cardboard, glass, and organic waste. Under each women CBO, approximately 5–7 households are divided into small groups. The CBO initially provides each group with a metal barrel (200-liter capacity) free of charge for composting the sorted organic waste. The survey data showed that about 3,930 kg/month of compost was produced during 2001, of which about 50% was used in the home gardens and the rest was sold. The average selling price of the compost was between Rs10–25/kg ($0.1– 0.25) depending on the location and quality of compost.

Source: AIT 2004

6.2 Private sector participation

The private sector has played an important role in MSWM of the countries mentioned in the paper. Especially in Kathmandu, the private sector is participating more in door-to-door collection, street sweeping, and waste transfer. Due to the involvement of the private sector, collecting garbage is found to be more efficient and, in addition to this, burden on the Kathmandu Municipal Corporation is reduced both in terms of financial and human resources. Approximately 50% of the people surveyed replied that services provided by the private sector were more effective. Therefore, the Corporation is gearing toward the involvement of the private sector in all aspects of solid waste management.

6.3 Nongovernment organizations

NGOs operate between the private and governmental realms. They are motivated primarily by humanitarian and developmental concerns. NGOs may help increase the capacity of people or community groups to play an active role in local SWM by contributing to:

- people's awareness of waste management problems;
- organizational capacity and formation of CBOs;
- provide channels of communication between CBOs and government authorities;
- championing of CBOs' voice in municipal planning and implementation processes; and
- transfer of technical know-how of locally active CBOs.

NGOs may also provide important support to informal sector waste workers and enterprises assisting them to organize themselves to improve their working conditions and facilities, increase their earnings, and extend their access to essential social services such as health care and schooling for children. While privatization basically involves the transfer of management responsibility and ownership from the public to the private sector and has proven to be a powerful means of improving the efficiency of some waste management services, such as collection, haulage, and disposal. Operating in various forms of partnership with the public sector, they may provide capital, management and organizational capacity, labor, and technical skills (United Nations 2000). This semiformal private sector includes a wide range of enterprises varying from informal microenterprises to large business establishments, other CBOs, and local enterprises.

In recent years (AIT 2004), Sri Lanka has gained a noticeable participation by the CBOs, NGOs, and local enterprises in promoting MSWM and increasing public awareness in resource recycling and waste minimization. In Nepal, NGO Zero Waste Nepal is working toward community-based SWM. Zero Waste Nepal is trying to develop new attitudes and behavior of the people toward handling waste and converting the existing "throw away" culture into "zero waste" culture. Also in Nepal, the Women's Environment Preservation Committee in Lalitpur started a pilot project supported by the Danish International Development Agency with waste reduction as its main objective. The group is working for source segregation and composting servicing 500 households with primary collection. The sweepers sort out the recyclables and sell them to waste traders while the organic waste is composted. The organization sells 1,200–1,500 kg of compost monthly (UNESCO report). Similarly, in Bangladesh, NGOs like Waste Concern, Prodipan, and Environmental and Geographic Information Systems are coming up with strategies to manage solid waste properly. Prodipan is working from collection of solid waste to composting and runs a small-scale incineration plant (WSP-SA 2000). A local NGO, Pakistan Environment Welfare and Recycling Program, Tetra Park, and Shehri are actively involved in SWM in Pakistan (Government of Pakistan 2005).

7. RECOMMENDATIONS

7.1 Technical Aspects

The adoption and transfer of the technologies from the developed countries without adapting them to the local or regional perspective would be fallacious on the part of the developing countries. Therefore, the technical aspects for a sustainable SWM would have to take into account the following points for planning and implementation of strategies:

- Provision of facilities for primary collection of waste from curbside/community bins and adequate storage facilities in the urban areas based on the population density.
- Transportation of waste from the community storage facilities at regular intervals and improvement in the waste collection fleet.
- Transfer stations (at optimal distances from residential areas) should be constructed wherever necessary with provision for weighbridges.
- There must be a separate SWM system for hospitals, health care establishments, and industries to prevent the infectious and hazardous wastes from entering the municipal waste stream.

7.2 Management Aspects

Sustainable SWM would call for the strengthening of the management sector which has to go hand-in-hand with technical planning. In most developing countries, overstaffed management due to politically motivated appointments result in absenteeism, and hence, the working efficiency decreases while at the same time there is a squeeze in resource allocation for technical aspects that get neglected. The effectiveness can only be achieved by a strong management that takes into consideration the following aspects:

- An executable master plan and implementation plans for MSWM at the provincial or state level in accordance with the strategy for national environmental quality would help the management;
- Application of Polluter Pays Principle to all waste generators, especially in urban areas including government and nongovernment agencies, private sectors, and commercial enterprises;
- Application of the 3R concepts, product stewardship, cleaner production, and specification in the selection of packaging materials to the manufacturers;
- Continuous monitoring and record keeping of MSW aspects with the development of a systematic information system that can be comparable, utilizable, and updated;
- Appointment of responsible government agencies that can regulate and supervise MSWM activities of both local government and private operators so as to reduce the environmental impacts;
- Provision of organizational support for encouraging the involvement of private sector operators, NGOs, and CBOs; and
- The informal sector needs to be formalized.

7.3 Financial Aspects

- There should be transparency and coordination among the staff regarding the operation and maintenance costs at each level of waste handling so that the expenses are rational;
- The levying of waste collection and disposal fees should be based on waste generation rates and according to the economic standard of the area, while considering the nature of the waste wherever necessary. However, these fees should not be levied solely to meet the financial lacunae for management and the equipment demand;
- The larger generators should be charged on excessive waste generation which could be prevented with cleaner production principles;
- There should be provisions for subsidies (grant, soft loan, etc.) from government to local authorities, including the private sector, NGOs, and CBOs;
- Tax exemption for importing recycling technology and reduced tax benefits from those industries using waste and scraps as raw materials;
- A fund or trust for promoting 3R needs to be developed instead of a microcredit program in the informal sector; and
- Transformation of 3R into financial terms or economic value is needed.

7.4 Legislative Aspects

Legislation and its effective enforcement is a key to sustainability for which the framework requires to be established. The related aspects are given hereunder:

- Set up of appropriate pollution discharge standards for solid waste disposal facilities, such as effluent and emission standards either based on World

Health Organization (WHO) norms or related to the national standards for pollution control;

- Declare all solid waste disposal facilities as pollution sources, which if done should be strictly enforced such that discharges should be regulated in pursuant to the established standards;
- Develop regulations and related laws to set up mechanisms for implementing 3R concepts—Reduce, Reuse, and Recycle;
- Regulate an appropriate SWM system for the mass transportation terminals;
- Declare a no-development buffer zone within 500 meters from the boundary of all processing and disposal sites; and
- The joint involvement of the Ministry of Finance, city planning offices, and the Ministry of Environment to develop infrastructure plans on the promotion of 3R is needed.

7.5 Supportive Aspects

Municipal bodies could have the required technology, financial resources, management structure, and a framework of legislation for effective SWM. However, its implementation cannot be effectual unless the supportive aspects are mobilized to work hand-in-hand with the system. This can be achieved if the system can:

- Encourage private sector involvement for waste collection, hauling, and disposal as both short-term and long-term contractors since efficiency is found to increase with their involvement;
- Promote public education program, trainings, and workshops; revise school curriculum by introducing the 3R concepts in general and SWM in particular; and reinforce social values for all children and citizens in the society;
- Initiate education and training programs in fostering technical and administrative capabilities to local government and private personnel;
- Encourage waste separation and recycling program at sources—households, commercial centers, institutions, and factories—by employing segregation strategy that would fit the appropriate waste collection and disposal practices;
- Encourage research and development projects for suitable technology in coping with the mounting MSW management problems and enhance management efficiency through established academic and research institutes; and
- Encourage coordination between stakeholders.

8. CONCLUSION

Municipal solid wastes (MSW) in South Asian cities still have many problems. The current regulation system is not perfect and the existing management system and the collection facilities do not fit the present requirements. MSWs are still collected without separation at the source, treatment facilities are limited, and the collected wastes are mostly dumped haphazardly in open areas. Government, NGOs, CBOs, and the private sector are working hard in this field, but, much still needs to be done. The main management strategies to remedy this should include amendment of current laws and regulations, improve current management systems, and introduce classified collections. The effective implementation of these strategies will help solve the environmental pollution problems to a large extent. It is also important to observe that there are possibilities for research implementation and collaboration among developing countries having similar climatic and solid waste characteristics.

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Box 3: Session Summary

Session I: Domestic Solid Waste Management

Presentation I: Domestic Solid Waste Management in South Asia (Prof. C. Visvanathan)

Presentation II: Japan's Experience in Environmentally Sound Waste Management and the 3Rs (Mr. T. Hasegawa)

Presentation III: Community-Based Solid Waste Management through Public-Private-Community Partnerships: Experiences of Waste Concern in Bangladesh (Mr. Maqsood Sinha)

KEY POINTS FROM THE PRESENTATION:

The management of municipal solid wastes (MSW) in South Asian cities still has many problems. The current regulation system is not perfect. Moreover, the existing management system and collection facilities do not fit the present requirements. MSWs are still collected without being separated at source, treatment facilities are limited, and most collected wastes are dumped haphazardly in open areas. The government, NGOs, CBOs, and the private sector

are working hard in this field, but much still have to be done. The main management strategies to remedy this should include amendment of current laws and regulations, improve current management systems, and introduce classified collections. The effective implementation of these strategies will help solve environmental pollution problems to a large extent. It is also important to observe that research implementation and collaboration among developing countries having similar climatic and solid waste characteristics are possible.

In Japan, 3R activities are promoted under the concept of "Sound Material-Cycle Society." As part of this fundamental waste management law, a collection of five recycling laws for container and packaging, home appliances (TV, refrigerators, washing machine, and air conditioner), construction materials, food wastes, and end-of-life vehicles have been developed and implemented. Both treatment and 3R technology are well-developed and implemented as part of the solid waste management program. Several cities and towns get together and constitute one wide area over which an efficient 3R system is planned and implemented. An integrated system with various facilities for the 3Rs, such as biomass utilization, recycling, waste power plants, asbestos treatment and so on, are formulated under close collaboration among cities and towns.

A detailed case study from Bangladesh demonstrated the importance of community-based solid waste management. Here, simple composting facilities were developed through public-private-community partnership programs, and later replicated in more than 20 cities and towns in Bangladesh.

KEY POINTS FROM THE TECHNICAL DISCUSSION:

- The promotion of 3Rs in domestic solid waste management overemphasizes "Recycle and Reuse" and less focus is given to "Reduction."
- The purchasing capacity in developing countries is quite low; hence, low quality products are produced which create more waste in quantity. As a result, 3R promotion is hindered.
- Developing countries cannot afford to use the technology from developed countries as it is. Adaptation is necessary. For example, in Bangladesh, road condition and soil are not suitable for the use of automatic sucking type technology to sweep roads.
- It is important to have the correct baseline data. A wrong calculation of waste quantity may result in importing more sophisticated equipment than necessary. The benefits of dumping technologies in developing countries are debatable. This needs a knowledge base to understand the technology, and to prepare an assessment procedure.
- The concept of the 3Rs must be formalized by government policy. Recycling should be market-driven and should be run like an industry, where there is a need to control both raw material and product quality.
- There is a need for a critical review of technology and the development of a "database" or a "knowledge center." In addition, it was revealed at the national level that there was a need for human resource development in this sector (both technical and managerial skills).

KEY POINTS FROM SOCIAL DIMENSIONS DISCUSSION:

- Poverty alleviation programs are the best way to promote the 3Rs in MSW and associated informal sector issues. A large number of informal sector workers in the region handling a significant part of the MSW management cycle is a clear indication of the level of poverty in a country. Thus, these two issues could be handled together at the national level.
- Through appropriate policy measures, the informal sector should be brought into a formal sector by considering the occupational, health, and safety issues.
- Women and children should not be used in scavenging work because they are vulnerable to health problems.
- At the national level, there is need to review carefully any cultural/behavioral barriers in promoting the 3R activities.
- School curriculum should include the 3R concept. Children should be taught about waste management and the 3Rs from the very beginning.

KEY POINTS FROM FINANCIAL AND ECONOMIC DIMENSIONS:

- The following issues need to be addressed:
  - Are there any provisions for subsidies (grant, soft loan, etc.) from government to local authorities, including the private sector, NGOs, and CBOs?
  - Is there any tax exemption for importing recycling technology and reducing tax benefits from those industries using waste and scraps as raw materials?
  - Is there any budget allocated for 3Rs activities such as awareness, motivation, etc.?
- A trust fund to promote the 3Rs must be developed, instead of a microcredit program in the informal sector. In traditional society, there were almost no waste problems; but with the development of modern society, waste has emerged as a problem. With this, the informal sector needs to be formalized. There is a business opportunity which must be promoted.
- Transformation of the 3Rs into financial terms or economic value is needed. The joint involvement of the Ministry of Finance, city planning offices, and the Ministry of Environment to develop infrastructure plans on the promotion of the 3Rs is needed. Coordination between stakeholders is important. The linking of 3R financing and environmental benefits is an issue. Another issue to be considered is how 3R can be used to meet the budget and expenditure of local governments.

2.3 3Rs for Industry

Fritz Balkau
Former Head of Sustainable Production and Consumption Unit of UNEP/DTIE

1. INTRODUCTION

Complex wastes, often with a significant chemical or bacterial content, are now an inescapable feature of contemporary society, even in the poorest countries. These materials generally become mixed with the normal waste stream, giving rise to problems in disposal and to recovery alike. Some wastes may even be imported for local disassembly or recovery. Traditional approaches to measuring urban waste only by volume overlook the special procedures needed to address such "industrial" residues in order to maximize their 3R potential. Similarly, wastes from industrial and commercial premises, despite their possible potential of recovery, are still too often released into the environment, degrading quality of water, air, and soil resources. In all countries, an examination of the 3R potential of industrial residues and postconsumer products and packaging could make a considerable contribution to economic potential while simultaneously avoiding health and environmental damage.

2. WHAT ARE INDUSTRIAL WASTES?

The issues surrounding the 3Rs for industrial wastes are complex not only because industrial wastes themselves are so varied, coming from a multitude of different sources, but, because many other wastes in the postconsumer stream, such as batteries, motor oils , paints, and solvents, electronic products or medical waste, have hazardous characteristics. Their management often depends on the same control systems as those used for residues from classic industrial production processes and 3R actions can thus often be combined. This apparent duplication can be overcome during policy development by speaking of "industrial and other hazardous wastes" (an approach also taken by the Basel Convention, for example). Whatever definitions we use, much common ground remains between the reduction, reuse, and recycling of industrial materials and the 3R procedures applied to municipal and domestic wastes.

3. GOVERNMENT FRAMEWORKS FOR 3Rs

As is the case for other waste sectors, effective industrial 3R programs depend on a clear government framework and policy priorities to avoid a fragmented series of individual actions that may have little impact on the overall waste stream or on materials conservation.

A basic condition for effective government policy in promoting 3R is that the reduction, reuse, and recycling of wastes should be regarded as a manufacturing activity that converts incoming materials (in this case wastes) into commercially viable products, in the process also creating economic value and local employment. This turns the historical view of recycling on its head—3R should not be seen in government policy as an environmental program that produces a few marginal goods; rather it should be promoted as a profitable mainstream economic production activity that has the side benefit of also reducing the wastes for disposal. This approach has a number of implications as we will see further on in this report. Here it should simply be noted that within an effective government and corporate framework have shown, this turnaround in vision is entirely possible by numerous case studies.

To support such a policy, government needs to ensure that necessary infrastructure for 3R processes is available in the form of scientific, technical, and educational networks that can support individual reduction, recovery, and recycling initiatives. Separate collection, storage, and transport systems for industrial and hazardous materials are part of this infrastructure. Successful 3R actions can best be taken and are most economically viable when there is a clear and firmly enforced set of pollution regulations which make it an offence to dump wastes into the environment. Under such circumstances 3R actions will be better able to compete with "no-cost" disposal practices. As recycling of industrial and postconsumer wastes often results in highly hazardous secondary residues specialized safe disposal facilities will still be needed even under 3R programs.

The regulatory framework also needs to ensure that legislation actually encourages reduce, reuse, and recycle,

and that, for example, financial penalties or purchasing prejudice against recycled products are removed, and that subsidies for virgin materials are also applied to recycled products. The legislative framework should also seek to influence the upstream side of wastes by defining a clear product policy concerning consumer and other products that can or should be recycled, or which pose problems in the general waste stream. Given the purchasing power of governments, a clear preference for green purchasing and preference for recycled products would help put 3R efforts on a better economic footing by creating a market for such products that the wider community can then also share.

In all of the above, the policy framework should give effect to making reduction the first priority. In many countries where this is not the case, the establishment of large, centralized treatment facilities has removed the incentive to reduction since these facilities need more waste to make their operations economic.

Other policy and infrastructure requirements are spelt out in more detail in the various workshop reports.

4. WASTE MANAGEMENT FRAMEWORK FOR 3Rs

Whatever may be the political, regulatory, and economic framework for reduction, reuse and recycling, a number of waste management procedures still need to be in place to provide support to general 3R campaign for industrial and hazardous wastes. The most important is for everyone to understand the nature of the waste stream to allow effective reduction actions to be taken (the first priority in waste management hierarchies). A variety of waste measurement techniques is available to allow government agencies to estimate the total national waste stream, and for individual producers to better appreciate the characteristics of what they have been throwing away. Such knowledge is essential for each of the 3Rs, including the reduction actions. It is especially necessary to estimate the "quality" of wastes that may become available for recycling so that operations are predictable and safe, and that the final end product is marketable. Despite the importance of measurement, however, once a minimum of data is available, prompt action, even temporary, should follow. We should not be content to simply study the problem.

The 3R programs will not abolish all waste, and recycling even produces its own secondary residues. There remains a need for treatment and disposal facilities, although with effective reduction programs these may be smaller and less complicated than is often the case now. We saw already that such facilities must, of course, be subject to adequate pollution standards.

A major issue for recycling is to avoid the mixing of wastes by the generators or the transporters. Mixed wastes are often impossible to recycle due to the presence of hazardous components, or simply because the valuable components are then too dispersed in a large volume of ordinary waste to be worth extracting. Better control over generation, storage, collection, and transport will do much to improve the viability of 3R options for almost all wastes, industrial or otherwise. As is already the case for prevention, source separation also should be seen as an investment, not as a cost, since it improves the economic viability of waste processing operations.

It is an unfortunate reflection on human nature that deliberate diversion and illegal mixing or contamination of valuable waste materials has frequently been recorded in the past. Waste motor oils contaminated by Polychlorinated Biphenyl (PCB), solvents mixed with incompatible liquids, and scrap steel contaminated by radioactive substances are just some of the problems observed in insufficiently controlled environments. There is no case to be made for relaxing the pollution or waste standards for recycling facilities until such practices are effectively and permanently stamped out.

Close control over transport and storage is a key factor in all of the above, as many undesirable actions are possible (and actually occur) in an uncontrolled and unregulated waste and materials transport sector.

An easy first step toward understanding the waste stream and to implement simple reuse options is to establish and industrial waste exchange. A number of countries have successful operating experience with such a procedure.

5. IMPORTANCE OF KNOWLEDGE TRANSFER

In an area with so many cross-cutting issues, it is natural that individual understandings and knowledge are at different levels in society. Many old ideas continue to circulate, as for example that pollution prevention costs too much, or that domestic waste is nonhazardous. Industrial 3R programs must be based on good understanding of issues, clear articulation of priorities, and effective capacity building of concerned individuals.

A first task is to make more accessible the extensive existing information on 3R options and economics. This implies networking rather than new research, although further pilot studies can be identified when the gaps in information are better understood.

Experience with information clearing houses in the past has shown that collection, analysis, and dissemination of information will be more effective if several agencies and sectors share the work, and use a common set of definitions and descriptors. A useful starting point would be to network existing clearing houses in the 3R areas to establish a common learning platform for all the key players.

The sources and targets of such information will differ according to the reduction, reuse or recycle objectives. In particular, for reduction work in the industry sector, information mostly concerns process technology and operations information, something that waste managers rarely have access to. The need for expertise in process engineering means that the network of reduction professionals has developed independently of the waste experts. A deliberate effort could be made to bring these constituencies closer together.

Information systems also need to incorporate upstream prevention issues related to product design and consumption patterns.

Pilot and demonstration studies have greatest value when they are filling an important gap in information. All pilot studies should incorporate an information dissemination phase (with clear funding allocation) to ensure the eventual learning experience is accessible to the community at large.

An important part of a 3R information campaign is outreach to political constituencies so that the policy framework can be improved. In this, there is a need to communicate about issues rather than about details, and to emphasize the social and economic and regulation aspects rather than the technologies. A political outreach campaign also needs to stress the development and social dimension of 3R programs and its important contribution to national development.

6. ECONOMIC DIMENSION OF 3Rs FOR INDUSTRY

Close attention needs to be paid to economic and financial aspects when designing 3R programs for industrial and hazardous wastes. The 3Rs bring economic benefits in terms of resource conservation and reduced pollution damage, but especially, they allow the development of a new economic activity sector to create jobs, markets, products and infrastructure which enrich society as a whole. A number of different areas require attention to achieve this.

First, more effort needs to go into education and promotion on the economics of reduction and prevention. A number of high profile international programs have been undertaken on this in the past; however, insufficient influential persons have been reached (or have not taken action) with the message that cleaner production, green productivity, eco-efficiency, etc. is actually an investment action, not necessarily only an environmental one. The message that prevention pays needs to become a more prominent feature of national 3R programs at all levels. Future resource centers should, thus, collect and disseminate such economic information widely to all constituencies.

Tax discrimination against recycled products and waste and pollution fees should be systematically reduced as an integral part of national 3R initiatives. Consideration of deposit-refund schemes for selected industrial and consumer products such as batteries, electronic goods, chemical containers, etc. could form part of such an initiative. The revenues could be used to promote further 3R projects and studies as is already the case in a number of countries.

Considering the significant purchasing power of governments, there is a real opportunity for leadership by readjusting purchasing and tendering along 3R lines. Once the government has created a market for green and recycled products, the civil sector and industry will be able to benefit from the availability of new markets in such goods and, thus, accelerate the commercial opportunities for the reuse and recycling aspect of 3Rs.

At the beginning of 3R programs a case can be made for government subsidies for a limited time to give the emerging operations and markets some assistance. In the long term, 3R initiatives need to stand on their own financial feet.

7. CHOOSING 3R TECHNOLOGIES

Once the social and political issues have been settled, further consideration of 3R technologies can occur. Engineering decisions at a too early stage may close the door on many other useful 3R options as we saw already above. The United Nations Environment Programme developed some years ago a process of technology assessment, under the name of EnTA, that incorporates environmental and social aspects.

We also note that several different technology types are involved in 3Rs. For the priority reduction aspects, what is needed is more efficient production technologies (often called zero, cleaner, or low-waste technologies) and end products that have a low environmental footprint and/or are economic to collect and recycle.

For recycling technologies, both economics and efficiency are important. As the incoming raw materials (i.e., wastes) may sometimes be contaminated with substances that diminish recycling effectiveness, the technologies must be carefully adapted to the waste stream. Where no controls on waste quality are in place, only very robust technologies are appropriate, and often these may not be economic nor will they produce a high quality marketable product. This problem is also acute where the waste stream is small and highly variable. Under such circumstances, a very high level of professional expertise must be available to operate plant. The EnTA technique mentioned earlier can also be used to evaluate the secondary residues from recycling plants, as this is often where much of the hazardous substances are concentrated. A sound disposal route may need to be part of the overall project for recycling some types of industrial or postconsumer waste. For small quantities of difficult waste, a regional approach to recycling may be the only economically viable option.

Many reduction options have their basis in improvements in operational management. Management systems such as ISO 9000 and ISO 14000 have been developed to allow a coherent approach. The use of supply-chain management and extended producer liability systems extends this consideration into the upstream and downstream directions. Product design based on Life Cycle Assessment (LCA) moves the considerations of prevention even further upstream into the product cycle. Such management systems have now become part of our understanding of the meaning of the term "technology."

8. SOCIAL ASPECTS

Social aspects of industrial 3R programs are strongly focused on worker health and safety issues, especially where mixed wastes are concerned. This is especially important on open dumpsites which receive industrial and commercial wastes, end in transport and collection. In these cases, an education and outreach program may be needed to make workers aware of the risks, but also directed in part to the waste generators to avoid unsafe storage and transport practices.

The important aspect of consumption patterns as, for example, through increased use of recycled products often has a strong social dimension.

9. FINAL COMMENTS ON REDUCTION AS PART OF 3Rs

Prevention and reduction are by definition not to produce waste, or at least to minimize it to the maximum extent possible. This is generally outside the field of experience of waste experts who have knowledge on how to handle wastes after it is produced (including recycling). A successful 3R program that emphasizes the first of the 3Rs, therefore, enlists several different professional constituencies simultaneously. For prevention, this means upstream experts such as process engineers (for industrial residues) and product designers and social scientists (for consumer wastes) to address the waste generation factors in society.

Industrial entrepreneurs have shown themselves to be well suited to take charge of the recycling aspects where there is a chance of a profitable operation. They will enlist waste managers and process engineers in their attempt to build a cost-effective recycling plant and to ensure quality control over incoming wastes.

For the prevention side, the upstream experts use specific tools and procedures to first discover the causes of excessive waste generation (including the cleaner production audit) and to identify reduction options such as materials substitution, product redesign, process changes, efficiency enhancements, etc.

Politicians and industrialists commonly believe (incorrectly as it turns out) that reduction costs money and, thus, detracts from development. Most studies invariably show that prevention pays, and that reduction is an investment rather than a cost. This message has been well-understood by some large companies that have improved their competitive position by avoiding the generation of unnecessary waste (which after all contains materials for which they have paid money). Sadly many governments have not yet understood this point. Small companies do not even think of this issue and continue to operate inefficiently until and unless their big industrial clients demand that they conform to their corporate policy on social and environmental responsibility. Supply chain management has been the greatest force moving small companies in the 3R direction. The world's biggest gold producer, Barrick Co., produced a poster on 3Rs for internal use in its various global operations.

The technology, economics and, operation of reduction action have been documented now for well

over 20 years around the world. Some companies have responded (and benefited), but the majority is still in the old mindset, following the common government policy of developing first with cheap and dirty technologies (the path taken by western countries, after all), then cleaning up later when we are wealthy. In fact, even wealthy countries have often found the clean-up budget beyond their resources.

The background experience and wealth of experience in cleaner production (CP), green procurement (GP), polluter pays principles (PPP), etc. now needs to be given a boost by the 3R initiatives and more strongly integrated into national 3R programs to make the first of the Rs a true priority for the benefit of all.

10. SUMMARY

Industrial and commercial wastes are a fact of life for all countries now. This problem cannot be treated separately from the issue of municipal waste since it is common in many situations for all wastes to be mixed. The 3R programs open the door to an important set of economic and environmental opportunities for industrial and hazardous wastes if the right techniques and procedures can be used.

Box 1: Session Summary
Session II: Industrial Waste

SESSION CONTENTS

Presentation 1: 3Rs for industrial waste (F. Balkau)
Presentation 2: EPR (M. T. Hashi)
Presentation 3: Sustainability in 3Rs (M. Kwaja)
Discussion on presentations
Discussion on the 3R principles
Discussion on crosscutting issues

KEY POINTS FROM PRESENTATIONS:

- Industrial waste has a very broad meaning, and generally includes a wide range of both hazardous and highly polluting residues that are chemical nature. Similar residues also arise from service industries and postconsumer items.
- All countries now produce such waste in varying quantities. When mixed with general garbage in collection systems and at dumpsites, the whole waste stream develops hazardous properties for workers and for the environment.
- Regulations on waste management and recovery exist in some countries, but, are generally not well implemented and enforced. This effectively leads to a zero-cost disposal option that competes with the environmentally sound 3R principle.
- Care is also needed to avoid inadequate ISO 14000 certification to 3R facilities which can lead to a false sense of quality, and ultimately, loss of confidence in the 3Rs.
- Some industrial recycling or recovery schemes already exist in most countries, but, may not function in an environment-friendly or healthy way. More emphasis is often needed to ensure that 3R activities are compatible with sustainable development.
- The lifecycle extended producer responsibility (EPR) framework is an upstream tool that can help avoid many problems, and ensure that products are recovered/recycled. It should be designed in accordance with conditions in relevant countries. EPR is useful for promoting the 3Rs, but, needs further refinement to better cover international trade in products.
- A waste exchange network is a useful first step for a general integrated approach to industrial 3R. As well as recovering useful materials for reuse, it leads to the creation of better communication and interaction with producers and users.

KEY POINTS FROM TECHNICAL DISCUSSIONS:

- Closer joining of management systems for domestic and industrial wastes can improve the 3R potential as often as the same wastes are found in both sectors.
- More effective enforcement of pollution control regulations helps assure a more visible and predictable stream of industrial and chemical wastes for recycling.
- Waste measurement and audits are important to pinpoint the real source of the problem and the

key players in waste generation. It is important, however, not to prolong the studies so as not to delay the implementation of concrete actions.

- Quality control of incoming waste streams based on effective source segregation and monitoring is necessary for the 3R technical options to meet their full potential and avoid problem of cross-contamination of the final recycled product.
- 3R policies must be emphasized more to promote the avoid/reduce actions to reduce the waste stream. This will depend on the outreach to and/or feedback from, production managers and design consultants rather than the waste experts.
- We can learn from companies that already practice the 3Rs with good outcome, including product design, clean manufacturing, and sometimes green purchasing.
- Industrial 3R fits best under a future-oriented manufacturing framework that aims at high-quality products, recycled raw materials, community-level employment, enhancement of manufacturing skills, and improved industrial infrastructure.
- 3R options depend critically on infrastructure services (such as, safe collection,transport contractors, laboratory facilities, trainings, and communication networks).
- Proper disposal facilities are still needed to deal with secondary wastes from recycling. Nevertheless, the 3R options are reduced where large central waste disposal systems such as incinerators are installed since these compete for available waste to cover investment costs. Waste disposal systems are best designed after practical 3R options have been exhausted and secondary waste composition is known.
- Transboundary transport issues must be examined to avoid pollutioning dumping, but conversely also for a possible sharing of facilities when facilities are costly.

RESULTS FROM DISCUSSION OF CROSSCUTTING ISSUES:

- Social issues in the 3R application to industrial waste include the important aspect of health and safety of workers, as well as impact from possible secondary pollution on the surrounding communities. Nevertheless, there are important benefits in creating employment in the low-skill sector. Cultural practices and perceptions strongly influence the use of recovered products but also employment prospects.
- The economics (i.e., cost) of supplied waste (including transport costs), and of markets for final products, dominate the financial issues surrounding industrial 3R in an open market economy. The recovery/recycling economics also need to be seen in the context of subsidized virgin products, for example non-subsidized compost competing with subsidized fertilizer. Many government and corporate purchasing policies discriminate against recycled products, even if the quality of these products are the same as new ones. Subsidies may be useful in the start-up phase of 3R projects until the products have established a secure market.
- Market conditions for recycled products are strongly influenced by the quality and dependability of the supply of products, pointing to the need for good control over the entire supply chain and to focus on the marketing of high-quality products rather than being content with low-quality—and hence, low value—ones.
- 3R technologies must be seen in the context of societal, management, and economic context to avoid inappropriate selection of technologies even if these have been successful elsewhere. More efficient production technologies that implement the reduce principle in the 3Rs are available in many industries.
- Conclusions of previous Cleaner Production (CP) studies show that CP will usually be profitable in the medium and long term despite higher initial costs sometimes (but not always).
- Clean recycling technologies are available for many wastes, but, it is difficult to find viable technologies for some that have small volumes or complex composition. Conversely for some wastes, recycling technologies exist, but, there are no current markets for the recovered products (e.g. mercury). There is a place in developing countries for indigenous research and development on 3R technologies for local situations and markets. Finally, it is important for all recycling technologies to evaluate the hazardous effects of secondary waste (e.g., lead recycling).

2.4 Health Care Waste Management in South Asia

C. Visvanathan and Radha Adhikari

Environmental Engineering and Management Program
School of Environment Resources and Development,
Asian Institute of Technology, P.O. Box 4, Klong Luang
Pathumthani 12120, Thailand

1. OVERVIEW OF HEALTH CARE WASTE MANAGEMENT

The World Health Organization (WHO) defines health care waste as total waste generated by hospitals, health care establishments, and research facilities in the diagnosis, treatment, or immunization of human beings or animals, and other associated research and services. A major fraction (75–90%) of the waste generated by health care facilities (HCFs) are, in general, non-risk waste and resemble residential and institutional waste. The remaining fraction (10–25%) is hazardous (risky) and may pose a variety of health risks (WHO, 1999). Hazardous health care wastes can be categorized into different groups as presented in Table 1.

Hazardous clinical wastes pose risks to individuals exposed to them (both within and outside establishments), to workers in waste disposal facilities, and scavengers. Potential hazards associated with these wastes, especially their effects on human health are paramount (Table 2). It is, therefore, necessary to examine such hazardous wastes from broader perspectives—that is, from generation to collection, storage, and disposal.

Table 1: Health Care Waste Categories and Descriptions

Waste category	Description and examples
Infectious waste	Waste suspected of containing pathogens (e.g., laboratory cultures, waste from isolation wards, tissues, materials or equipment having been in contact with infected patients, and excreta)
Pathological waste	Human tissue or fluids (e.g., body parts, blood and other body fluids, and human fetuses)
Sharps	Sharp waste (e.g., needles, infusion sets, scalpels, knives, blades, broken glasses, etc.)
Pharmaceutical waste	Waste containing pharmaceuticals (e.g., expired pharmaceuticals or no longer needed, contaminated items or containing pharmaceuticals [bottles, boxes])
Genotoxic waste	Waste containing substances with genotoxic properties (e.g., waste containing cytotoxic drugs [often used in cancer therapy], genotoxic chemicals)
Chemical waste	Waste containing discarded chemical substances (e.g., laboratory reagents, film developer, disinfectants which are expired or no longer needed, solvents)
Wastes with high content of heavy metals	E.g., batteries, broken thermometers, and blood pressure gauges
Pressurized containers	E.g., gas cylinders, cartridges, and aerosol cans
Radioactive waste	Waste containing radioactive substances (e.g., unused liquids from radiotherapy or laboratory research, contaminated glassware, packages or absorbent paper, urine and excreta from patients treated or tested with unsealed radionuclides)

Source: WHO (1999)

Table 2: Health Effects and Potential Hazards from Clinical Wastes

Potential hazards	Health effects
Infectious agents	Respiratory infections, genital infections, skin infections, Meningitis, AIDS, Viral Hepatitis A, B, and C
Radioactive	Cancer, burn and skin irritation, headache, dizziness, and vomiting
Sharps	Double risk: injury and potential transmission routes for HIV, and Hepatitis B and C from contaminated sharp
Pressurized containers	Injury from explosion
Hazardous chemicals	Intoxication, burns and skin irritation, pollution of groundwater, surface water and the air, possibility of fire, poisoning
Pharmaceuticals	Ineffective medical care from the consumption of expired pharmaceuticals, pollution of groundwater, surface water, and air
Genotoxic waste	E.g., batteries, broken thermometers, and blood pressure gauges
Pressurized containers	E.g., gas cylinders, cartridges, and aerosol cans
Radioactive waste	Carcinogenic and mutagenic, skin or eye irritation, nausea, headache, or dermatitis

Source: WHO (1999)

2. GENERATION, COLLECTION, STORAGE, AND TRANSPORTATION

2.1 Waste Generation

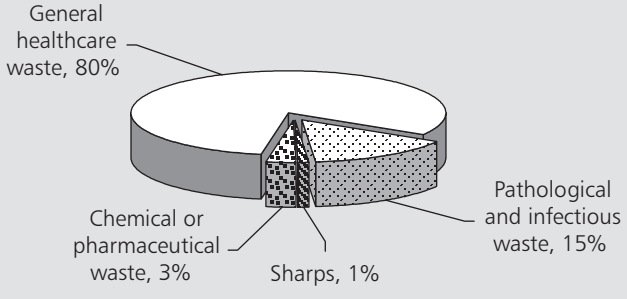
The quantity and composition of health care waste vary between and within countries. This variation can be attributed to the size of establishments, proportion of in- and outpatients, type of institution and specialization, available waste segregation options, proportion and use of reusable items, wealth of user, and the prosperity of the country. Generally, low- and middle-income countries generate low health care waste compared to high-income countries. Health care waste generation in high-income Asian countries varies from 2.5 to 4 kilograms (kg)/bed/day while it is 1.8 to 2.2 kg/bed/day in low-income countries. In North America, specific waste generation is as high as 7–10 kg/bed/day (WHO, 1999). Similarly, the composition of the waste varies, depending upon the country's economy. Composition of health care waste in developing countries is presented in Figure 1.

2.2 Waste Collection Guidelines

The collection of health care wastes is to be done separately to facilitate easy storage, transportation, and treatment. Some guidelines for medical waste collection, as recommended by WHO, are:

- Daily or frequent collection and transportation of the waste to the storage.
- Bags are to be labeled with their point of production (hospital and ward or department) and contents. Unlabelled bags are not to be collected.
- Bags or containers are to be replaced immediately with new ones of the same type, which should be readily available at the source of origin.
- Bags and containers for infectious waste are to be marked with the international "Infectious Substance" symbol.
- Highly infectious waste should, whenever possible, be sterilized immediately by autoclaving. Red bags are recommended for autoclaving.
- Obsolete and expired pharmaceuticals are required to be returned to the pharmacy for disposal.
- Separate collection of waste with high heavy metal content (e.g., cadmium or mercury).

Figure 1: Health Care Waste Composition in Developing Countries



Source: WHO (1999)

2.3 Storage Guidelines

It is essential to have a designated storage location within the health care establishment. Table 3 presents some of the recommended color coding techniques and types of containers to be used for storage (Figure 2). WHO-recommended guidelines for health care waste are:

- Storage: An impermeable, hard-standing floor with good drainage, and an adequate water supply to clean and easy to disinfect;
- Good lighting and at least passive ventilation and protection from the sun;
- Storage area should not be situated proximate to fresh food stores or food preparation areas; and
- Supply of cleaning equipment, protective clothing, and waste bags or containers should be located conveniently close to the storage area.

2.4 Transportation Guidelines

WHO guidelines for transportation of health care waste are:

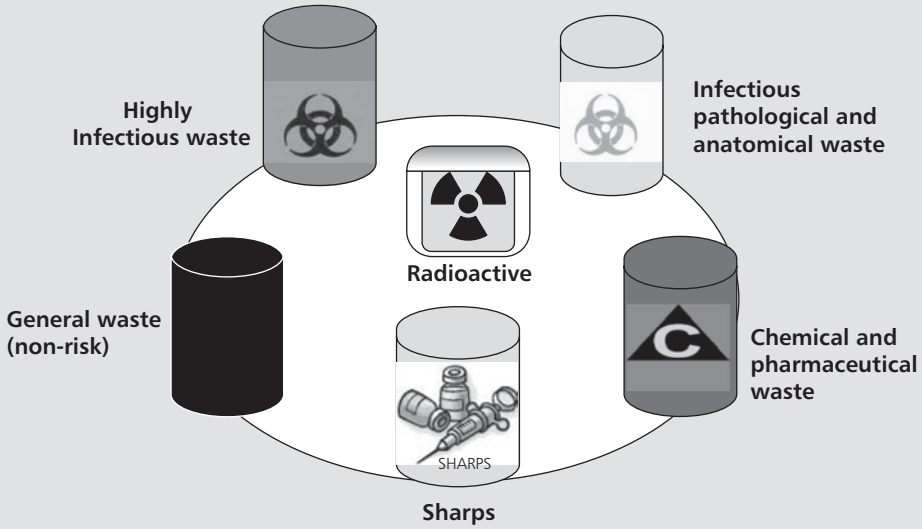
- Transportation of medical waste within the medical institution (i.e., from the point of generation to storage) can be done by small trolleys or carts.
- Transportation of waste may be done during less busy hours and through routes that are less exposed to people.
- Transportation from the point of origin to the onsite or external treatment facility can be done by specialized trucks marked with symbols denoting the type of waste carried.
- Suitable licenses should be provided for hazardous and low-level radioactive wastes. The driver of the vehicle should be knowledgeable of medical waste and the measures to be taken in case of an accidental spillage.

Table 3: Recommended Color Coding for Various Wastes

Type of waste	Color of container and markings	Type of container
Highly infectious waste	Red	Strong leak-proof plastic bag or container capable of being autoclaved
Other infectious waste, pathological and anatomical waste	Yellow	Leak-proof plastic bag or container
Sharps	Yellow, marked "SHARPS"	Puncture-proof container
Chemical and pharmaceutical waste	Brown	Plastic bag or container
Radioactive waste	–	Lead box, labeled with the radioactive symbol
General health care waste	Black	Plastic bag

Source: WHO (1999)

Figure 2: Collection Containers with Different Color Coding and Labeling



Source: WHO (1999)

The vehicle used for transporting health care waste should not be used for any other material and should be marked clearly with the contact details and address of the service provider. The route used for transporting health care waste to the treatment plant should be preplanned and transported as quickly as possible to prevent any exposure to radiation that would affect the public.

3. TREATMENT TECHNOLOGIES

Although treatment technologies and disposal methods differ for each type of waste, segregation at source into different categories reduces the management, operation, and treatment costs along with the risk of infection with these contaminants. WHO recommended treatment options for each category of waste as presented in Table 4. It is to be noted that no single technology is ideal for all kinds of biomedical waste and for all scales of operation. Commonly used technologies are incineration, landfilling, burning, autoclaving, and chemical treatment. Microwave disinfections, plasma touch technique, detoxification, and advanced wet oxidation are some emerging technologies. A new solar treatment technology developed in India is presented in Box 1.

Box 1: Ecofriendly Medical Waste Disinfection: Solar Treatment

- Choithram Hospital and Research Centre India has developed a box-type solar cooker that disinfects waste by exposing it to the sun's rays.
- It is made up of an upper cover that supports a reflecting mirror and a lower metal box. Waste is fed into the box with water and exposed to the sun's rays for 6 hours.
- Though it is unable to completely destroy all bacteria, the level of bacterial reduction seems satisfactory.
- It is found beneficial for developing countries, particularly for small-scale operation in rural areas, despite its inability to kill heat-resistant bacteria.
- Technology option is cheaper to operate, environment friendly, and does not require skilled manpower. It also fits into a rural setting where microwave and autoclave are not affordable.

Source: Jamwal (2004)

Table 4: Treatment Options for each Category of Waste

Options	Infectious	Anatomical	Sharps	Pharmaceutical	Cytotoxic	Chemical	Radioactive
Rotary kiln	✓	✓	✓	✓	✓	✓	Low-level
Pyrolytic incinerator	✓	✓	✓	Small quantities	X	Small quantity	Low-level
Single-chamber	✓	✓	✓	X	X	x	Low-level
Drum or brick incinerator	✓	✓	✓	X	X	x	x
Chemical disinfection	✓	X	✓	X	X	x	x
Wet thermal treatment	✓	X	✓	X	X	x	x
Microwave irradiation	✓	X	✓	X	X	x	x
Encapsulation	X	X	✓				x
Safe burial on hospital premises	✓	✓	✓	Small quantity	X	Small quantity	x
Sanitary landfill	✓	X	X	Small quantity	X	x	x
Inertization	X	X	X	✓	✓	x	x
Other methods				Return expired drugs to supplier	Return expired drugs to supplier	Return unused chemicals to supplier	Decay by storage

Source: WHO (1999)

✓= recommended; X= not recommended

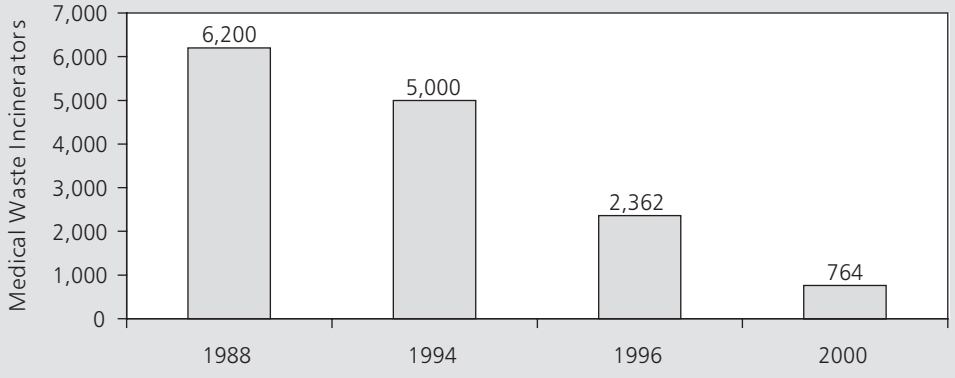
Technology selection requires clear thought as each of these technologies has their own merits and demerits (Table 5). Treatment technologies are also influenced by prevalent standards, policies, and legislations. For example, the United States Environmental Protection Agency's stringent pollution control standards and effective enforcement caused a decline in medical waste incinerators and increase in alternative technologies in the United States (Figures 3 and 4). One of the reasons for the unpopularity of incinerators is due to dioxin emissions. Box 2 presents information on dioxin.

Table 5: Advantages and Disadvantages of Different Technologies

Treatment technologies	Advantages	Disadvantages
Incineration	• Reduction of waste volume and weight • Acceptability for all waste types • Heat recovery potential	• Public opposition, larger space, and footprint required • High investment and operation cost • Formation of dioxins and furans linked to serious health problems including cancer • High maintenance, testing, and repair cost • Vulnerability to future stringent emissions standards
Autoclave Disinfection	• Encourages reuse and recycling • Commercially available in varying sizes (from desktop to industrial) • Low investment and operating cost • Ease of operation • Creation of residue that is less hazardous than incineration	• Inability to change waste volume and waste appearance • Lack of suitability for some waste types (e.g., low-level radiation, toxic contaminant) • Production of uncharacterized air emissions and odor problems
Microwave Disinfection	• Significant volume reduction • Absence of liquid discharges	• High investment cost and increased waste weight • Lack of suitability for some waste types • Potential to expose workers to contaminated shredder • Production of uncharacteristic air emissions
Chemical Disinfection	• Significant waste volume reduction • Ability to make waste unrecognizable and easy to use • Waste deodorization • No combustion by-products	• Possible toxic by-products in wastewater • Lack of suitability for some waste types • Production of uncharacterized air emissions • Need for chemical storage and use
Electron Beam Gun Technology	• Waste volume reduction (20%) • No toxic emissions or discharge (except for small amounts of ozone) • A room temperature process and nothing is added (e.g., steam, water, chemicals, etc.) • Well-automated technology and requires little operator time	• High investment cost and operation cost • Shields and safety is necessary to prevent workers from ionizing radiation
Plasma pyrolysis	• Suitable for all types of waste and results in reductions (up to 80–90% in volume and in weight)	• Suitable for very large hospitals and regional treatment facilities • Still at the demonstration scale

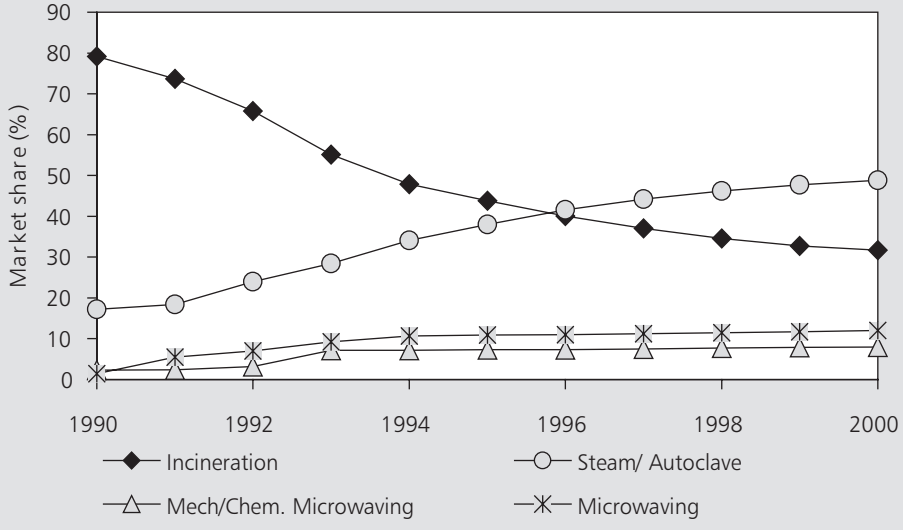
Source: Health care without Harm (2001); WHO (1999)

Figure 3: Usage of Medical Waste Incinerators in the US between 1988 and 2000



Source: Singh, 2003

Figure 4: Trends in Medical Waste Disposal Technologies in the US



Source: Agrawal, 1998

Box 2: Dioxins—An Unseen Deadly Incineration By-product

- A member of the "dirty dozen" list of persistent organic pollutants or POPs;
- Known carcinogens linked to birth defects, immune system disorders, and other harmful health effects;
- Created when PVC plastic or any other chlorine-containing material is burned in the presence of organic matter;
- Increased disposables in medicine leads to an increase in plastics going to incineration;
- Very expensive to monitor and control (i.e., to analyze the presence of dioxin in human tissue, there are less than 50 laboratories in the world certified by WHO to conduct this and the cost per sample varies between $1,000 and $3,000); and
- PVC containing medical products are:
  - Colostomy and blood bags;
  - Intravenous tubes and syringes;
  - Catheters, urine bags;
  - Plasma collection bags;
  - Infusion sets ,draw sheets; and
  - Vinyl gloves, sharp containers.

Source: Singh (2003); Health Care without Harm webpage

4. HEALTH CARE WASTE MANAGEMENT IN SOUTH ASIA

Health care waste management in South Asia is an impending disaster. Mushrooming clinics and health centers, often unregistered, clearly have created an environmental havoc by disposing their biomedical wastes scattered in and around their establishments attracting flies, insects, and rodents, etc. that are responsible for the spread of communicable diseases. Waste management, even in government hospitals, is less than satisfactory. Uncontrolled burning, reuse of disposable items, unintentional injuries from improperly discarded sharps are common and lead to life-threatening infections such as Hepatitis B, C, and HIV (World Bank, 2000). The following sections describe the state of health care management in South Asia.

4.1 Legislation Governing Health Care Waste Management

4.1.1 Bangladesh

The Bangladesh Environment Protection Act, 1995 defines pollution as:

"contamination or alteration of the physical, chemical, or biological properties of air, water, or soil, including the change in temperature, taste, turbidity, odor or any other characteristics of these or such discharge of any liquid, gaseous, solid, and radioactive substance, the discharge, disposal, and dumping of which may cause adverse/negative changes in the environment."

There is no specific legislation pertaining directly to the handling, transportation, or disposal of medical waste in the Bangladesh Environmental Protection Act (1995). However, wastes are classified under Section 2 (1) as "any liquid, solid, and radioactive substance that is discharged, disposed, or dumped which may cause adverse/negative change to the environment."

4.1.2 Bhutan

Currently, there are no separate rules for health care waste management in Bhutan; they are handled as part of the 1995 Water and Sanitation Rules. The 1995 Water and Sanitation Rules briefly discuss the guidelines for collection, transportation, and disposal of solid waste from different sectors. However, existing legislation lacks clear categorization of biomedical waste and hazardous waste (UNEP, 2001a). Applicable rules related to HCFs are presented below:

- Pathogenic and infectious waste shall be collected in a sterilized container or disposable bag and incinerated at the Jigme Dorji Wancghuck National Referral Hospital or treated by decomposition in slaked lime. Incinerated ash and fully decomposed treatment residue shall be disposed of in the same manner as waste from residents.
- Special hospital and pharmaceutical wastes shall be collected in labeled boxes and disposed of in a manner that would prevent accidental contact with a collection worker or the public. The disposal of these wastes in public waste bins or container is prohibited.

4.1.3 India

The Government of India enacted the 1998 Biomedical Waste (Management and Handling) Rules, making it mandatory for such health facilities liable for the segregation, packing, storage, transportation, and disposal of wastes. Biomedical wastes are classified into 10 categories (Table 6) and the different types of color-coded containers assigned for the different categories corresponding to the treatment and disposal methods are given. Incineration, deep burial, autoclaving, microwaving, disinfection, and disposal in landfill are among the disposal options (Table 7). The 1998 Biomedical Waste (Management and Handling) Rules has been amended twice: first, on 6 March 2000, the rules concerning waste management facilities for the treatment of waste were changed; and second, on 2 June 2000, defined the role of the different institutions including the municipal body, Pollution Control Boards/Committees and Authorities (WHO, 2005).

4.1.4 Maldives

The Environmental Protection and Preservation Act (4/93) enacted in April 1993, established a framework upon which regulations and policies can be developed to protect and preserve the natural environment and resources for the benefit of future generations. Although Clause 7 mentions that disposal of waste, oil, and poisonous substances shall be regulated, there are no separate rules related to health care waste management.

4.1.5 Nepal

The only legislation directly related to waste management in Nepal is Solid Waste Management and Resource Mobilization Act (1987) which created the Solid Waste Management and Resource Mobilization Centre (SWMRC).

Table 6: Categorization as per Biomedical Waste Regulation

Category	Type of waste
1. Human anatomical waste	Human tissues, organs, body parts
2. Animal waste	Animal tissues, organs, body parts, carcasses, fluids, blood; experimental animals used in research, waste generated by veterinary hospitals
3. Microbiology and biotechnology waste	Waste from laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell cultures used in research, infectious agents from research and industrial laboratories, from production of biological wastes, toxins, dishes, and devices used to transfer cultures
4. Waste sharps	Needles, syringes, scalpels, blades, glass, etc., capable of causing punctures and cuts. These include both used and unused sharps.
5. Discarded medicines and cytotoxic drugs	Waste comprising outdated, contaminated, and discarded drugs and medicines
6. Soiled waste	Items contaminated with blood fluids including cotton, dressings, soiled plaster casts, linens, beddings
7. Solid waste	Disposable items other than the waste sharps, such as tubing, catheters, IV sets, etc.
8. Liquid waste	Waste generated from laboratories, washing, cleaning, housekeeping, and disinfection activities
9. Incineration ash	Ash from incineration of any medical waste
10.Chemical waste	Chemicals used in the production of biological material , disinfection, insecticides, etc.

IV = intravenous

Source: The Gazette of India (1998)

Table 7: Segregation, Storage, and Treatment Options of Biomedical Waste in India

Waste category	Type of container	Color code	Treatment options with standards
Human anatomical waste	Plastic bag	Yellow	Incineration Temperature of primary chamber: 850±50°C Secondary chamber: 1050±50°C Stack height: 30 m Deep burial Pit: 2 m deep Lime cover: 50 cm
Animal waste			
Microbiology and biotechnology waste			
Soiled waste			
Microbiology and biotechnology waste	Disinfected container/ plastic bag	Red	Autoclaving 121°C at 15 psi for 60 min. 135°C at 31 psi for 45 min. 149°C at 52 psi for 30 min Microwaving *Bacillus subtilis* as an indicator in the form of spores using vials or spore strips with at least $1x10^4$ spores per ml
Soiled waste (body fluids, cotton, dressings, soiled plaster casts, linens, items, contaminated with blood catheters, intravenous sets, etc.)			
Waste sharps	Plastic bag/ puncture proof container	Blue/white translucent	Autoclaving 121°C at 15 psi for 60 min 135°C at 31psi for 45 min. 149°C at 52 psi for 30 min. Microwaving *Bacillus subtilis* as an indicator in the form of spores using vials or spore strips with at least $1x10^4$ spores/ml
Discarded medicines and cytotoxic drugs	Plastic bag	Black	Disposal in secured landfill
Incineration ash			
Chemical waste			

°C = centigrade; cm = centimeter; m = meter; min. = minute; ml = milliliter; psi = pounds per square inch

Source: The Gazette of India (1998)

Later, the Local Self-Governance Act (1999) transferred the responsibility of waste management to local bodies. The country does not have any program for hazardous waste management. There are no policies and legislations dealing with such waste. The government does not define hazardous waste and any standards for its management is lacking. It is not clear which government agency is responsible for dealing with issues related to hazardous waste (UNEP, 2001 b).

4.1.6 Pakistan

The legislation regarding health care waste is covered by the Pakistan Environmental Protection Act of 1997. It includes the disposal and handling of hazardous waste along with the national environmental quality standards. Although the national environmental quality standards do not specifically mention health care waste, the standards highlight that pollution from any such sources entering air, water, or land should not exceed the prescribed limits. The Pakistan Environmental Protection Act of 1997 has prohibited the handling of hazardous substances, which can only be dealt by those under license.

Chapter 1, item 2 (xxi) describes the definition of hospital waste as:

"waste from medical supplies and materials of all kinds, as well as waste blood tissues, organs, and other parts of the human body from hospitals, clinics, and laboratories" (UWEP, 1997).

In response to increased environmental concerns, the Government of Pakistan enacted the Hospital Waste Management Rules in 2005, which defines the different categories of hospital wastes. The rule provides procedures for the establishment of waste management systems and describes roles and responsibilities of the different personnel working in the hospital including the techniques for segregation, handling, storage, transportation, and disposal of hospital wastes in a safe manner (Government of Pakistan, 2005).

4.1.7 Sri Lanka

The National Environmental Act is responsible for environmental protection in Sri Lanka. The National Environmental Act No. 47 of 1980 along with amendments No. 56 of 1988 and No. 53 of 2000, are the basic legal documents that regulate the management of health care waste in Sri Lanka. But in reality, these legal instruments are of no use as far as the health sector is concerned due to technical/legal oversight. At present, there is no proper legal framework to regulate it (UNEP, 2001 c).

4.1.8 Summary

In general, most South Asian countries lack legislations directly related to health care waste management. It is addressed in the national policies in some countries, such as Bhutan and Sri Lanka. Guidelines and/or policies regarding such wastes do not exist in some countries. A summary of legislation, policies, and guidelines is presented in Table 8.

4.2 Generation of Health Care Waste

To prepare a well-planned waste management system, it is essential to know the quantity of waste generated as well as the different waste categories in a particular establishment. The quantity of health care wastes generated in South Asia largely differs within countries, primarily due to their economy. An estimate of hospital waste generation in some countries in South Asia is reported in Table 9. Since data on waste quantities are not maintained by all hospitals, the specific waste generation rate is difficult to obtain. Specific waste generation rate per bed in some South Asian countries is presented in Figure 5.

4.2.1 Bangladesh

There are currently 645 public and 288 private sector health care establishments in Bangladesh (Akter and Tra¨nkler, 2003). Roughly 20% of total medical waste generated in Dhaka is categorized as infectious/hazardous (Nessa et al., 2001). The average generation is 0.55–1.10 kg/bed/day, with about 0.17 kg/bed/day of hazardous material. World Bank estimates that about 36,000 tons (t) of health care waste is generated every year in Bangladesh. Hospital wastes often get mixed with domestic solid waste. The Bangladesh University of Engineering and Technology (BUET, 1999) conducted a study in some hospitals in Dhaka and found that an average rate of medical waste generation was 1.0 kg/bed/day. In a separate study by the same university in different hospitals in the capital city in 1997, it was found that the rate of waste generation was about 1.16 kg/bed/day, and the hazardous waste was 0.169 kg/bed/day. The percentage of infectious, sharps, and pathological wastes was about 10.5%, 3.5%, and 1.5%, respectively.

Table 8: Summary of Legislation, Policy, and Guidelines in South Asian Countries

Country	Legislation
[1]**Bangladesh**	No proper legal framework to regulate health care waste in the 1995 National Environment Act
[2]**Bhutan**	Guidelines for Infection Control (Ministry of Health) Health care waste management is addressed; Environmental Code of Practice for Hazardous Waste Management, 2001 Policy
[3]**India**	Biomedical Waste Regulations (1998) (1st amendments: March 2000 & 2nd amendments: June 2000)
[4]**Maldives**	No separate rules related to health care management in the Environmental Protection and Preservation Act of 1993
[5]**Nepal**	No policies and legislation dealing with hazardous waste
[6]**Pakistan**	Hospital waste management rules, August 2005
[7]**Sri Lanka**	No proper legal framework to regulate health care waste in the National Environmental Act. A draft of national policy in health care waste management exists (2001)

[1] Nessa et al. (2001) [2] Royal Government of Bhutan (2004)
[3] Government of NCT Delhi, (2002) [4] UNEP (2002) [5] UNEP (2001b)
[6] Government of Pakistan (2005) [7] UNEP (2001c) & World Bank (2002)

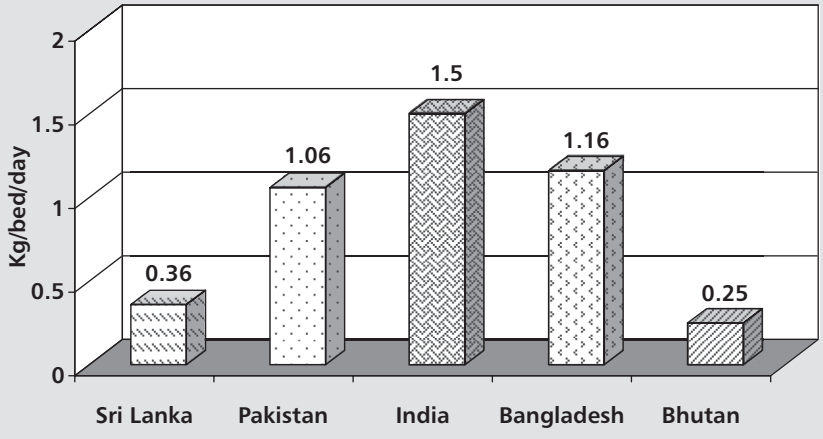
Table 9: Generation of Hospital Waste in South Asian Countries

Country	Waste generation (Kg/bed/day)	Annual waste generation (t)
Bangladesh	0.8–1.67[i]	93,0755 (255 per day)[vii]—only in Dhaka
Bhutan	0.27[ii]	73[viii]
India	1.0–2.0[iii]	0.33 million[ix]
Maldives	–	146* [x]
Nepal	0.5[iv]	2,018[xi]
Pakistan	1.63–3.69[v]	0.25 million[xii]
Sri Lanka	0.36[vi]	6,600—only from Colombo[xiii]

*includes waste oil from electric generator and vehicles; kg = kilogram; t = ton

[i] Rahman et al (1999) [ii, viii] Royal Government of Bhutan (2004)
[iii] Agrawal (1998) [iv, xi] MoH (2001) [v] UWEP (1997)
[vi, xiii] Basnayake (2001) [vii] Akter & Tra¨nkler (2003)
[ix] Patil & Shekdar (2001) [x] UNEP (2002)
[xii] Government of Pakistan (2005)

Figure 5: Average Hospital Waste Generation in Some South Asian Countries



Source: Basnayake (2001), UWED (1997), Agrawal (1998), Nessa et al. (2001), RGOB (2004)

4.2.2 Bhutan

There are 29 hospitals (including referral and district) and 160 basic health units (BHUs) in Bhutan. While there has been no assessment of waste generated, it has been estimated that 73 t of infectious waste and sharps are generated annually in Bhutan. From this, approximately 54 t/year are from the hospitals and the rest from the BHUs (Royal Government of Bhutan [RGOB], 2004). Estimated infectious waste generation was 0.25 kg/patient/day and sharps production was 0.02 kg/patient/day. More details on the HCFs and their waste generation are presented in Table 10.

4.2.3 India

The country's urbanization growth has brought about the rapid establishment of medical facilities in urban centers than in rural areas. Waste management systems in the urban areas are already overburdened. The specific system ensuring separation of infectious and noninfectious waste at source is necessary for an efficient management of health care waste.

At present, separate systems for disposal of such type of waste are available in only a few establishments. Reckless disposal of infectious wastes with municipal waste further aggravates the problem.

In Delhi alone, there are 620 hospitals with 32,000 beds and 893 dispensaries. This number may be lower as more hospitals and nursing homes have been registered in recent years (Government of National Capital Territory [NCT] of Delhi, 2002).

The quantity of waste generated varies between hospitals and depends on the type of the facility and local economic conditions. The quantity of medical waste generated in Bangalore alone is more than 9.22 t/day (Table 11). For the entire country, the annual estimate is 0.33 million t. The composition of the waste shows infectious waste (30–35%) , plastics (7–10%), disposable syringes (0.3–0.5%), glass (3–5%), and general wastes including food (40–45%)

Table 10: Health Care Waste Generation in Bhutan (2000)

District	Hospitals (kg/year)		Basic health units (kg/year)	
	Infectious Waste	Sharps	Infectious Waste	Sharps
Bumthang	605	48	312	8
Chhukha	2,750	220	936	23
Dagana	0	0	936	21
Gasa	0	0	312	8
Ha	913	73	624	13
Lhuntse	768	61	1,040	26
Mongar	5,193	415	1,768	44
Paro	1,676	134	312	8
Pemagatshel	1,145	92	416	10
Punakha	1,421	114	520	13
Samdrup Jongkhar	4,257	341	1,768	39
Samtse	3,068	245	1,248	31
Sarpang	2,552	204	1,456	34
Thimphu	17,311	1,385	624	13
Trashigang	4,297	344	1,976	49
Trongsa	603	48	520	13
Tsirang	624	50	624	16
Wangdue Phodrang	577	46	1,040	23
Yangtse	830	66	312	8
Zhemgang	1,849	148	1,560	36
Total	**50,435**	**4,035**	**18,304**	**437**

Source: RGOB (2004)

(Patil and Shekdar, 2001). A survey found the proportion of solid waste generated as given in Table 12 in various hospitals of Indore. The quantity varies widely depending upon the estimation method and nature of health care establishments. An approximate estimate of 1 to 2 kg of waste/bed/day has been reported by Agrawal (Agrawal, 1998). The specific waste generation in Mumbai is presented in Table 13.

4.2.4 Maldives

A study conducted in 1998, shows that 0.4 t of hazardous waste is generated in Male and this includes clinical waste and oil from electric generators and vehicles (UNEP, 2002).

4.2.5 Nepal

With the growth of country's urban population, there has been a significant expansion of HCFs. This resulted in a sharp rise of hazardous solid waste generation. The Environment and Public Health Organization estimated that there are 2,347 beds in government hospitals and 1,558 beds in private hospitals and nursing homes, which generate about 1 t of infectious wastes per day. Most of the medical wastes are discarded along with the municipal wastes and only a small proportion is burned in health care institutions which have incinerators and autoclave treatment facilities (UNEP, 2001 b). Hospitals and nursing homes in the Kathmandu Valley alone produce over 250 kg of hazardous medical wastes each day (The Rising Nepal, 2005). The total amount of health care waste generation estimated by the Ministry of Health is presented in Table 14.

4.2.6 Pakistan

In Pakistan, around 250,000 t of medical waste is annually produced from all sorts of HCFs (State of Environment Report, 2005, Government of Pakistan). A study conducted by Scott and Purphy and NESPAK (1997) has revealed that waste from government hospitals in Karachi varies between 1.63 kg/bed/day and 3.69 kg/bed/day with an average of 3.02 kg/bed/day. The generation rate at private hospitals in Karachi was assessed to be 5.13 kg/bed/day. Based on these results, the total hospital waste generation in Karachi is assessed to be 100 t/day. Table 15 shows the quantities and composition of hospital waste generated from different cities in Pakistan.

Table 11: Quantity of Waste Generated in Bangalore

Type of Institution	No. of Beds		Quantity of Waste generated in Kg/day
	Government	Private	
Major Hospitals (> 500 beds)	2,486	5,047	3,766
Major Hospitals (200 to 499 beds)	2,599	2,269	2,434
Less than 200 beds	3,084	2,765	2,924
Non-bedded health care establishments (clinics, laboratories, blood banks, dispensaries, and medical centers)	0	0	100
Total	**8,169**	**10,081**	**9,224**

kg = kilogram; > = greater/more than

Source : The Energy Resources Institute, Bangalore

Table 12: Proportion of Different Solid Waste in Indore City

Type of waste	Average (%)
General	71.37
Infectious	18.83
Pathological	8.11
Chemical	0.91
Sharps	0.78

Source: Patil & Shekdar (2000)

Table 13: Total Waste Generated per Patient in Mumbai

Hospital	Total waste (per kg/ patient/day)
Private (20 beds)	0.25
Private (21–50 beds)	0.19
Private (> 50 beds)	0.98
Municipal	1.08
Government	0.70

kg = kilogram; > = greater/more than

Source: Agrawal (1998)

4.2.7 Sri Lanka

Several hazardous waste surveys were conducted by different institutions: Central Environment Authority Hazardous Substances Survey (1988), Pre-Feasibility Study on Hazardous Waste Management and Disposal for Sri Lanka; and the Environment Resource Management (1997). The latest Environment Resource Management (1997) study estimates that waste generation from registered government health care system is 6,600 t per annum. This assumes an average waste generation of 0.36 kg/bed/day for a registered 50,091 beds. Waste generation from small private clinics is excluded in this estimation. The generation of clinical waste from different government hospitals in Colombo is presented in Table 16.

5. PREVAILING HEALTH CARE WASTE MANAGEMENT PRACTICES

Health care waste is recklessly disposed of into the municipal solid waste landfill or open dumpsite in most Asian countries (Figures 6 and 7). In India, incineration technologies are still being propagated despite their potential risk of releasing dioxins (Singh, 2003). Regulations and standards are in the early stage of development and implementation and enforcement of rules are still underway. In general, people are unaware of the risks posed by medical waste. There is an urgent need, therefore, to establish clear protocols for safe and secure collection, treatment, and disposal of sharps to minimize the risks associated with disease transmission.

Table 14: Estimated Total Amounts of Health Care Waste Generated in Nepal (2001)

Health care facility types	kg/day
Small HCFs,*	456
Health Posts,** Subhealth Post,**& Outreach Clinics***	1,910
Medium HCFs**	1,130
Large HCFs**	2,034
Total	**5,530**

*For HCF with beds: 0.5 kg/patient/day

** For Health Post and Subhealth Post: 0.5 kg/HCF/day

*** For Outreach clinics: 0.1 kg/HCF/day.

HCF = health care facility; kg = kilogram

Source: MoH (2003)

Table 15: Hospital Waste Generation in Different Cities of Pakistan

City	No. of hospitals surveyed	Total No. of beds	Generation Rate in kg/bed/day
Karachi	5	3,500	1.20
Lahore	6	4,188	1.05
Rawalpindi	9	1,552	0.99
Multan	4	1,235	1.46
Faisalabad	9	1,546	1.00
Gujranwala	9	1,037	0.98
Sargoda	6	435	0.71
Total	**48**	**13,493**	**1.06 (average)**

kg = kilogram

Source: UWEP (1997)

Table 16: Generation of Clinical Waste in Colombo

Government Hospital	Registered Number of Beds/Cots	Estimated clinical waste (kg per day)		
		General Clinical Waste	Sharps	Total
		(0.33 kg/bed/day)	(0.03kg/bed/day)	(0.36 kg/bed/day)
Army	—	179	16	195
Ayurveddic	306	101	9	110
Cancer Institute	634	209	19	228
Castle Street	396	131	12	143
Colombo North	1,067	352	32	384
Colombo South	668	220	20	240
De Soysa	423	140	13	153
Dental Institute	42	14	1	15
Eye	471	155	14	169
Fever	90	30	3	33
National	2,722	898	82	980
Police	130	43	4	47
Sri Lanka Air Force	56	18	2	20

kg = kilogram
Source: Basnayake (2001)

5.1 Bangladesh

An estimated 255 t of medical waste is generated in Dhaka every day. Most of which is dumped in municipal bins (Rahman and Ali, 2000).Only a few hospitals have onsite management systems such as burning, burial, autoclave, and/or waste segregation. Some medical colleges and tertiary government hospitals have incinerators onsite. Even though no alternative method is prescribed, the Department of Environment (DoE) does not permit the operation of incinerators due to environmental concerns. Some private institutions and NGOs operate their own incinerators for infectious waste. A few hospitals store waste in their net houses or closed dustbins before sending them to the city corporation bins. Generally, solid wastes, saline bags, and non-sharps are disposed of improperly. An overwhelming number of waste pickers in Bangladesh sort these waste and sell everything that can be recycled. These waste pickers do not wear protective clothing, thereby, exposing themselves to injury and sickness. Moreover, the municipal dustbins of Dhaka, where the hospitals place their waste are left exposed to the environment for days before collection (Akter et al., 1999). A study conducted by Akter and Tra¨nkler (2003) revealed that apart from separating syringes/needles, hospitals do not practice waste segregation before disposal. Problems of proper management were:

- No specific institute responsible for medical waste management;
- Lack of cooperation within and among various agencies is a pertinent problem;
- Few local initiatives have been undertaken by some NGOs. Lack of awareness of potential risks;
- Hospital authorities tend to overlook health issues as it involves large sums of money;
- Lack of in-house management. Selected items like saline bags and containers are recycled centrally in some hospitals; and
- Unauthorized medical waste segregation, recycling, and reuse are often conducted in and outside hospitals by informal sectors.

5.2 Bhutan

The National Environment Commission passed an Environmental Assessment Act in July 2000 and issued a number of guidelines to support it. The handling of solid waste is addressed in the Environmental Code of Practice for Solid

Figure 6: Spoiled Medicine Capsules Dumped Together with Municipal Solid Waste in Dumpsite (Nonthaburi, Thailand)

Source: AIT, 2006

Figure 7: Infectious Waste in Red Plastic Bag is Co-disposed with Municipal Solid Waste

Source: AIT, 2006

Waste Management in Urban Areas (prepared in October 2000) and in the Environmental Code of Practice for Hazardous Waste Management that was issued in November 2001. RGOB, with the cooperation and support of the Danish International Development Agency (DANIDA), is in the process of developing a national infection control and health care waste management program.

5.3 India

In 1997, the Supreme Court passed a rule for the installation of incinerators in all hospitals with bed strengths above 50. After Sristi's (an NGO) intervention, the court directed the Central Pollution Control Board (CPCB) to allow non-dioxin creating technologies—such as waste autoclaves

and microwaves—and set standards for such technologies. In a survey performed on May 1997 by Sristi, 82% of the incinerators were burning mixed waste and 80% of the incinerators were not maintaining the temperature norms. The temperature was found optimum for dioxins and furans formation (190–400°C).The incineration industry worldwide has proven itself to be phenomenally unpopular, it being the highest source of dioxin releaser. The dioxin level in Delhi, based on Sristi's report, is presented in Box 3.

In consideration of the Rules and Guidelines for Biomedical Waste Management and their implementation, an audit was conducted by the Controller and Auditor General in Delhi (Government of NCT of Delhi, 2002). This study revealed that the present status of implementation of these rules is far from satisfactory and the objectives have scarcely been achieved. Some findings are:

- 27 out of 44 hospitals failed to ensure proper segregation, treatment, and disposal of biomedical waste.
- Some hospitals, including the All India Institute of Medical Sciences, did not comply with the instructions regarding the labeling of bags containing biomedical waste.
- Hospital authorities did not take sufficient measures to create public awareness in biomedical waste management implementation program.
- Hospitals used the same wheelbarrow for transportation of all categories of waste to the disposal points.

Box 3: Dioxins in Delhi

- In a recent study, dioxin was measured in tissues of humans, fishes, chickens, lambs, goats, predatory birds, and Ganges River dolphins, collected from various locations in India.
- Concentrations of dioxins were found in most of the samples analyzed, the liver of the spotted owlet containing the highest concentration of 3,300-picogram/gram fat weight, while in human fat tissues , they existed in concentrations ranging from 170 to 1,300 picograms/gram fat weight.
- As compared to WHO limits of 1–4 picogram/kg of body weight, these contamination levels are seriously alarming.

Source: Singh (2003)

- Biomedical waste was not lifted in time and was retained at generation point, that is, beyond 48 hours of its generation. Incineration facilities were underutilized and the temperature of incinerator not maintained as per CPCB norms.
- In the absence of proper fencing of incineration plants, rag pickers in one of the hospitals were seen shifting biomedical waste with bare hands, exposing themselves to health hazards. Moreover, used syringes, needles, intravenous (IV) sets, etc., were observed to have been recycled and resold in some hospitals.
- IV sets, tubes, catheters, plastic bags, syringes, gloves, etc. that are required to be autoclaved were incinerated causing pollution problem.
- Personal protective equipment was not provided to health workers or to those working at incinerators and autoclaves.

5.4 Nepal

As mentioned earlier, there are no state-level policies regarding the management of hazardous waste to check and monitor its disposal. Haphazard disposal of medical waste has been a threat to public health and a source of environmental pollution for Kathmandu Metropolitan City. A wide range of institutions (such as municipalities, the Ministries of Health, and Environment) are involved in this sector, but, their responsibilities in the management of such waste are not clear. Most municipalities now dump their hazardous waste along with municipal waste causing a major public health risk. Few individual health care institutions have set treatment facilities such as incinerators and autoclaves to treat their waste, mainly under foreign assistance. No guidelines are imposed for the establishment of waste incinerators in the country. The operational working temperature in incinerators was below the desired value. According to researches conducted by some independent experts, though some hospitals in Kathmandu are using incineration to manage waste, a number of nursing homes in core areas of Kathmandu Valley are generating medical wastes causing a dire impact on public health.

More than 90% of health care institutions do not practice safe waste handling, storage, and disposal methods and most health care institutions rely on municipal services for their ultimate disposal. In Kathmandu Valley, Tribhuvan University Teaching Hospital and Patan Hospital

have incinerators to treat their wastes. Other hospitals and HCFs, however, rely on containers provided by the Kathmandu Municipality. Bir Hospital, the country's oldest hospital, has been in a peculiar position ever since local residents destroyed its incinerator a few years ago. Teku Hospital treats patients affected by all kinds of infectious diseases—including human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), Hepatitis B and C, and cholera—and the absence of incinerators forces it to dump infectious waste in normal containers, threatening the health of local residents (Poudel, 2002).

According to the study conducted by the Save the Environment Foundation, hospitals collect all medical wastes including pathological wastes, syringes, bandages, and others in a normal bin and dump them into municipal containers. Personnel who handle those wastes do not even use gloves while dumping the material. In the absence of legislation mandating the safe disposal of medical wastes, the authorities are unable to regulate the activities of health institutions.

5.5 Pakistan

A survey reveals that none of the government hospitals has proper arrangements for waste disposal and there is also a concern that costly apparatus meant to be used once is sometimes reused. Much of the wastes are plastic—such as tubes and syringes—and rubbish scavengers pick them from solid waste dumping sites and then sold. Sanitary staff of hospitals are involved in selling disposable wastes to various parties for recycling. The buyers send the wastes for repacking and recycling. Drug addicts often reuse the disposable syringes lying in rubbish drums. In addition, birds, animals, and insects can transfer infections from wastes to human bodies.

According to a study, an average Pakistani uses five disposable syringes per year, making a demand of about 750 million syringes. It says Pakistan imports over 250 million syringes and 500 million syringes are produced locally under suspicious conditions. Most of these 500 million disposable syringes are often used in rural areas (Pakistan Press International, 2006).

Hospital waste management practices are not same in all hospitals. Some hospitals try to manage their wastes properly. Aga Khan University Hospital is one such example (Box 4).

Box 4: A Good Practice—Aga Khan University Hospital, Pakistan

- More than 2,500 in- and outpatients a month;
- Waste handling is the responsibility of the Housekeeping Section of the Maintenance Department with 210 housekeeping staff and 13 managers;
- All new personnel must attend a 15–20 day training course prior to starting work. Housekeepers and incinerator operatives are required to wear uniforms, including protective gloves and face masks.
- Waste is separated at the point of generation into different coloured bags;
  - o Infectious, pharmaceutical, and chemical waste ➔ double red bags
  - o General solid waste ➔ green bags
  - o Kitchen waste ➔ blue bags
  - o Disposable surgical items such as used syringes, sharps, etc. ➔ puncture proof containers marked 'danger'
- Green and blue bags are carried to a storage site where the recyclable material (e.g., paper and plastics) is separated and sold to private contractors;
- Kitchen waste (e.g., organic waste) is ground and disposed of in the municipal sewer system. The remaining waste is transported by the Karachi Metropolitan Corporation to the municipal landfill site;
- Human wastes, such as blood and urine, from treatment rooms and wards are disinfected before sending them to the municipal sewers. Liquid wastes such as blood and urine from the laboratories are flushed into the municipal sewers via underground neutralizing tanks containing calcium carbonate and other disinfectants. Chemical wastes are first deactivated within research laboratories before going through neutralizing tanks; and
- The red bags are placed in closed containers and, when full, are wheeled to the incinerator located in the hospital premises; residual ash is transported by a private contractor to the municipal landfill site.

Source: Appleton and Ali (2000)

6. EFFORTS ON IMPROVEMENT OF HEALTH CARE WASTE MANAGEMENT

6.1 Improved legislation, guidelines, and policies

To address mounting health and environmental concerns, South Asian countries are giving more attention to improve legislation and guidelines related to health care waste management. As an example, India enacted the 1998 Biomedical Waste Management Rules and two amendments in 2000. Similarly, Pakistan also enacted the 2005 Hospital Waste Management Rules. A draft version of the 2001 National Policy on Health Care Waste Management exists in Sri Lanka. Bhutan, through the Ministry of Health, has also established an infection control policy under the Guidelines for Infection Control in Health Care Settings. Health care waste management policy is addressed in the Environmental Code of Practice for Hazardous Waste Management that was issued in November 2001. Efforts to manage hospital waste are continued in Bangladesh. A committee of the DoE suggested guidelines, entitled: Biomedical Waste Management and Process Guideline/Rules (2000, 2001). This was put forward to identify environment-friendly techniques for hospital waste management in Dhaka. The directorate general of health service under the Ministry of Health and Family Welfare has published a manual for Medical Waste Management in 2001. Similarly, Nepal Health Research Council (in cooperation with WHO) prepared and published the National Health Care Waste Management Guidelines and Training Manual for Medical Professionals, which address health care waste management and other related issues.

6.2 Moving toward better technology

Incinerators that were thought to be the best method of eliminating infectious organisms are now considered environmentally unpopular because of toxic pollutant emissions. Governments in the region are beginning to realize that investing in incinerators only cannot solve the medical waste problem. DoE, Dhaka City Corporation, for example, realized this environmental concern due to incineration and does not permit such operation although alternative methods are not prescribed. Recently, in India, installation of individual incinerators is also discouraged and health care units are urged to treat their waste in common biomedical waste treatment facilities. Acknowledging economic and environment ramifications, many private hospitals decided to shut down incinerators and look for nonburn technologies (Perappadan, 2004).

WHO and the United Nations Development Programme, together with Health Care without Harm, have taken initiatives to reduce the release of dioxins and mercury to the environment by promoting best practices and techniques. The project funded by Global Environmental Facility is to be impended in seven participating countries, India included.

6.3 Role of NGOs and other activates

NGOs and communities are playing increasingly vital roles in medical waste management in South Asia. An example of a successful operation of health care waste management by an NGO (Prodipan) is found in Khulna City, Bangladesh as presented in Box 5. An NGO named Sristi, in India, played a key role in discouraging incineration technology, pushed for court intervention successfully to direct CPCB to emphasize nonburn technology. Also in India, the Centre for Environmental Education developed and implemented an Integrated Health Care Waste Management Plan and implemented in few hospitals in Delhi through a training and awareness program. With support from WHO, the Centre for Environmental Education also developed a national kit on biomedical waste management to educate people (The Hindu, 2004). Similarly, the Save the Environment Foundation (an NGO under the Colorado Nepal Environmental Exchange Program) has played a significant role in highlighting the consequences of Nepal's current practice of disposing hazardous medical wastes and drawing the attention of the government to the matter.

6.4 Role of the principle of reduce, reuse, and recycle (3Rs)

The environment has become a global concern in recent years. Waste management and recycling measures in general and reduce, reuse, and recycle (3Rs) initiative in particular, have come into international focus for sustainable development. One of such initiatives is G8 '3R' Action Plan and Progress on Implementation (2004). The most important challenge in 3Rs is the reduction in waste generation and environmentally sound waste disposal and treatment.

Box 5: Hospital Waste Management Program in Bangladesh (Public-Private Partnership)

- The World Bank's Water and Sanitation Program (WSP), with the support of the Swiss Agency for Development and Cooperation (SDC), launched a community-based solid waste management project in Khulna in 2000.The project was locally implemented by Prodipan, a national NGO, with the participation of 20 private hospitals and pathological laboratories.
- Khulna Hospital Waste Management includes training programs in segregating wastes into: syringe, saline bag and, other plastics; gauze, bandages, human organs; paper materials and others; and kitchen waste.
- Collection staff of the program collect and transport by specially-designed vehicles.
- All sharps (e.g., needles, blades) and plastics are placed in a concrete pit with a lockable lid. All bandages, gauze, cotton, body parts, and paper are burned in a locally-made incinerator.
- Plastic items such as syringes and intravenous (IV) bags are disinfected by immersing in chlorine solution. Then, they are destroyed by a shredder machine to prevent reuse.
- There is a shallow concrete-lined pit with a tin shed for the temporary storage of nonplastic infectious items such as bandages, cotton.
- Each participating institution is paying a monthly service charge between 100 taka (Tk) and Tk 600 ($1.5–9) depending on the volume of waste generated.
- At present, no external support charges are being collected and which are sufficient to cover the running costs. Improved technology (such as autoclaving for sterilizing infected plastic items) must be introduced, which may then be safely shredded and disposed of. This will greatly reduce the risk of infection.

Source: Ahmed et al. (2006)

Prevailing practices in health care have become an important source of environmental pollution and potential harm to health. Heavy metals (such as mercury, pathogens, and endocrine disrupters) are present in many health care products. In this connection, no opportunity should be left to apply the principle of 3Rs in hospital waste management. Out of 3Rs, source reduction has higher potential to be implemented in hospital waste management. Source reduction, as the key component, lies at the top of the hierarchy in integrated solid waste management. It reduces the amount of materials produced and the harmful environmental effects associated with it. This proactive approach offers several benefits such as resource conservation, avoided waste collection, transportation, and disposal costs, decreased pollution control, liability, and regulatory compliance costs, reduced product and material use, and disposal costs. Some of the potential source reduction practices are given below:

- Segregation: Waste segregation can drastically reduce the volume and toxicity of the waste stream. The volume of infected waste can be reduced after proper segregation and significant cost can be saved for its treatment.
- Material/device substitution: Proper procurement practices (e.g., changing the products and materials) can help reduce the harm. There are some viable substitutes for many products that contain PVC plastic, mercury, etc. For example, mercury-based thermometer can be substituted by electronic sensor devices.
- Segregation of medical products containing PVC. Dioxin production through incineration can be avoided by not allowing such items to go to incinerators.
- Use first-in and first-out policy in dispensing drugs and chemicals.
- Increasing awareness of hospital staff and management employee training in hazardous materials management and waste minimization.

7. CONCLUSIONS AND RECOMMENDATIONS

The major fraction (75–90%) of waste generated by HCFs is, in general, nonrisk waste and resembles residential and institutional wastes. The remaining fraction (10–25%) is hazardous (risky) and may pose a variety of health risks. Therefore, the concept of "source separation" as a priority action must be promoted.

The volume of the waste generated in some of the countries (Bhutan, Maldives) is too small to have economically viable treatment plants. Thus, a regional approach could be developed in terms of waste color coding, transboundary movement of these wastes for treatment. In terms of treatment technology, nonincineration-based

technologies must be promoted. However, a detailed technical review and a potential technology development must be done. Few demonstration projects should be set up, at the earliest, to develop a local know-how on these technologies. Greater care should be taken in terms of the radioactive waste generated from this sector. Radioactive waste generated, though low in quantity, can cause high impacts.

Hospitals should be directly responsible for their own waste management like an industry. However, an appropriate national strategy should be developed to handle the large number of "clinic" wastes. Subsidies are not a recommended option for health care waste management. However, a viable financial mechanism should be developed for small- and medium-scale clinics.

At the moment, neither the medical staff nor the administrators pay adequate attention to hazardous waste management and waste minimization. As a priority, this culture must be changed and these two stakeholders should play a very important role in this sector of waste management. Frequently, both waste pickers and common people should be informed about the need for proper management of health care waste. They could be educated to inform the concerned authorities to report potential illegal disposals. Greater budget should be allocated to implement awareness and training programs for hospital waste management. Provisions for fines for violators and economic incentives for good practices should be developed.

There is a trend toward medical treatment beyond the national boundary (e.g., people from Europe, US, and South Asia visit India for treatment). This issue should be given due consideration and economic analysis of such treatments should be done.

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Box 6: Session Summary
Session III: Medical Hazardous Waste

Presentation I Healthcare Waste Management in South Asia (Mr. C. Visvanathan)

Presentation II Problems and Issues of Medical Waste Management in Kathmandu Valley – Nepal (Mr. Rajesh Manadhar)

KEY POINTS FROM THE PRESENTATION:

- The major fraction (75–90%) of the waste generated by health care facilities are, in general, non-risk wastes and resembles residential and institutional wastes. The remaining fraction (10–25%) is hazardous (risk) and may pose a variety of health risks. Therefore, there is a need to promote the concept of "source separation" as a priority action.
- The hazardous fraction of health care waste poses risks to individuals exposed to such wastes (both within and outside establishments) workers in waste disposal facilities, and scavengers. It is, therefore, necessary to examine such hazardous wastes from broader perspectives—from generation to collection, storage, and disposal.
- Commonly used technologies are incineration, land filling, burning, autoclaving, chemical treatment, microwave disinfection, and plasma touch technique. These treatment technologies are influenced by prevalent standards, policies, and legislations. For example, United States Environmental Protection Agency's stringent pollution control standards and effective enforcement caused the decline in medical waste incinerators and an increase in alternative technologies in the US. Whereas in India, incineration technology was strongly promoted by the government through subsidies. Incinerators are operated more like a backyard burner in many parts of the country. Hospital incinerators are the biggest dioxin releasers in Delhi.
- In South Asia, mushrooming clinics and health centers (often unregistered) are the major source for operational problems in health care waste management.
- In general, most South Asian countries lack legislations directly related to health care waste management. It is addressed by national policies in some countries like Bhutan, Nepal, and Sri Lanka. Guidelines/policies regarding such waste do not exist in Maldives. Pakistan and India have basic legislations and standards related to healthcare waste. All these countries, however, lack enforcement of these regulations.
- The quantity of health care waste generated in South Asia largely differs within countries, primarily due to their economy. India (330,000 tons (t)/year) and Pakistan (250,000t/day) are on the higher end, while Maldives (146t/year) and Bhutan (73t/year) are on the lower end.
- Some of the potential source reduction practices in the health care sector could be:

– Segregation: Waste segregation can drastically reduce the volume and toxicity of the waste stream. The volume of the infected waste can be reduced after proper segregation and significant cost can be saved for its treatment.
– Material/device substitution: Proper procurement practices can help reduce the harm. There are some viable substitutes for many products that contain polyvinyl chloride (PVC) plastic, mercury, etc. For example, mercury-based thermometers can be substituted by electronic sensing devices.
– Segregation of medical products: Dioxin production through incineration can be avoided by segregating PVC plastics from the waste.
– Use first-in and first-out policy in dispensing drugs and chemicals
– Increase awareness of hospital staff and management employees in hazardous waste management and waste minimization.

KEY POINTS FROM THE TECHNICAL ISSUES:

- Health care waste management is a national priority environmental management issue. However, the application of the 3R concept must be reviewed very carefully. If proper source separation is practiced, the amount of hazardous waste will be very small. Greater attention should be given to the "reuse and recycle" potential of this waste segment.

- Greater care should be taken in terms of the radioactive waste generated from this sector. Radioactive waste generated, though low in quantity, can cause high impacts.
- In terms of treatment technology, nonincineration based technologies must be promoted. However, a detailed technical review and a potential technology development must be done. Adaptation has to be investigated. If possible, few demonstration projects should be set up, at the earliest, to develop local know-how on these technologies.
- The volume of the waste generated in some of the countries is too small to have economically viable treatment plants. Thus, a regional approach could be developed in terms of waste color coding and transboundary movement of these wastes for treatment .

KEY POINTS FROM THE SOCIAL ISSUES:

- At the moment, neither medical doctors nor hospital administrators pay adequate attention to "waste management." This attitude must be changed. These two stakeholders should play a very important role in waste management.
- In general, it was agreed upon that hospitals should be directly responsible for waste management (like an industry). However, an appropriate national strategy should be developed to handle the large number of "clinic" wastes.
- Frequently, both waste pickers and common people should be informed about the need for proper management of health care waste. They could be educated to inform the concerned authorities to report potential illegal disposals.
- There is a trend toward medical treatment beyond the national boundary (eg., people from Europe, South Asia, etc, go to India and Thailand for treatment). This issue should be given due consideration; an economic analysis of such treatments should be done.

KEY POINTS FROM THE ECONOMIC ISSUES:

- Most problems are in government hospitals where lack of budget is the reason for not managing hospital wastes.
- Subsidies should not be provided for this waste management sector. However, a viable financial mechanism should be developed for small- and medium-scale clinics.
- Bigger budget should be allocated to implement awareness and training programs for hospital waste management.
- Provisions for fines for violators and economic incentives for good practices should be developed.

2.5 Perspective of Electronic Waste Management in South Asia: Current Status, Issues and Application of 3Rs

Amit Jain
Managing Director
IRG Systems South Asia Pvt. Ltd.
K-71, Hauz Khas Enclave, New Delhi 110016
India

1. BACKGROUND

The electronics industry is one of the largest and fastest growing manufacturing industries in the world. Its growth is propelled by the rapid obsolescence rate of manufactured products. Therefore, obsolete electronic products are now the fastest growing waste streams in the industrialized world. The release of many different materials and components from these waste streams is hazardous in nature and may pose risks to human health and environment. The developed countries are addressing these risks by developing and institutionalizing E-waste collection, transportation, recycling, and disposal systems in a particular geographical setting under applicable regulations. The fundamental basis for institutionalizing this system requires establishing baseline inventory, estimating existing and forecasting material flows in a geographical setting. The studies in the European Union indicate that E-waste generation in the union was about 6 million tons (t) per year during 1998, which is growing at a rate of 3–5% per year. However, the developing countries, which are poised to generate major quantities of E-waste by the end of this decade, lack such type of data, adequate regulations, and facilities. In developing countries, most E-waste is either recycled in informal sector and its residues are disposed off in dumpsites. Uncontrolled recycling and dumping lead to environmental problems. In South Asia, both transboundary movement and recycling in the informal sector have been reported recently. This article gives an overview and analysis of the current status of E-waste management in South Asia, major issues, and possible solutions, including the application of the 3Rs.

2. CURRENT STATUS

The current status of E-waste management has been described in terms of generation, imports, inventory, and financial implications in South Asian countries.

2.1 India

Published reports in 2003–2004 indicated that E-waste is becoming an important issue in India. It has been further reported that it is being generated from domestic sources as well as imported from other countries.

In light of these reports, a pilot assessment on the existence of E-waste and its recycling for the region of greater Delhi was carried out under the guidance of the Central Pollution Control Board/Ministry of Environment and Forests (CPCB/MoEF). The pilot study focused on E-waste generation from personal computers, the economics of its recycling and environmental, health, and social issues associated with its rapid growth in Delhi region. The study indicated that the estimated E-waste in Delhi from personal computers during 2003–2004 is 6,803t, with 7 years obsolescence rate.

The outcome of the pilot assessment reported that personal computers dismantled in the national capital region of Delhi might reach 700,000 to 800,000 per annum by 2010. The E-waste recycling trade economics from personal computers indicated that the yearly sales turnover during 2002–2003 was $5 million with 941,274 yearly manhours spent on recycling and 10–20% profit margin. The re-gunning of the cathode ray tube (CRT) was found to be most profitable recycling business, followed by plastic shredding.

As a follow-up to the pilot study, a national-level desk study was carried out under the guidance of CPCB/ASEM program of GTZ, to assess the quantum of E-waste being generated at the national level and to identify states and cities requiring rapid assessment.

The desk study assessed market size and growth for Information and Communication Technology (ICT), brown goods, and white goods segments. The results of this report were reported in a national workshop, organized by MoEF and GTZ, held on 4 June 2005 in Delhi. The report indicates that computers (ICTs), TVs (brown goods), refrigerators, and washing machines (white goods) will drive the future growth of the electronics hardware industry in India. The data captured through Market Supply Method for 2004-2005 show that the estimated market size of personal computers (15,464,637), colored and black and white TVs (11,750,000), refrigerators (4,800,000), and washing machines (1,700,000). The growth rate of computers has been estimated to be 25%, while it varies from 15–20% annually for all other items. The obsolescence rate of computers has been established at 7 years; for TVs, washing machines, and refrigerators, 15 years. The E-waste inventory based on this obsolescence rate and installed base in India for 2004–2005 has been estimated to be 14,618,000t. This is expected to exceed 16,000,000t by 2012. Ten states generate 70% of the total E-waste in India. Maharashtra ranks first, followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh, and Punjab. Among the top 10 cities generating E-waste, Mumbai ranks first, followed by Delhi, Bangalore, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat, and Nagpur.

Two E-waste recycling facilities, one in Chennai and the other in Bangalore, are operating in India. However, the bulk E-waste recycling facility in India exists in the informal sector.

2.2 Pakistan

E-waste generation has been reported from domestic sources as well as imports in Pakistan. As per the Basel Action Network (BAN) report, preliminary investigations in Pakistan reveal that it is receiving and processing western-originated E-waste. Preliminary estimates show that the penetration rate of personal computers in Pakistan is less than 10 per thousand people (World Bank 2002). However, no inventory of E-waste has been prepared or reported so far.

In Pakistan, circuit boards are reported to be desoldered with blowtorches with no ventilation fans while acid operations take place indoors with less ventilation. The major E-waste market has been reported to be Sher Shah in Karachi, where electronic, electrical, spare parts, and computers arrive by sea and land for sale or further distribution to other cities in Pakistan.

Only 2% out of the total E-waste available in open markets is re-used with slight repair, while the rest is used for extraction of metals and plastics. Products extracted from the computers include copper, gold, platinum, plastics, lead, and glass. No special equipment or protective clothing of any kind is used during dismantling.

The BAN report further states that the typical costs of a scrap purchase in Dubai is around Pakistani rupees (PRs) 35–40 ($0.65) per kilogram, whereas costs from Singapore were reported to be being around PRs200 or $3.27 per kilogram. The plastic casing of the monitor is either burned openly or is sold at a price of PRs10 per kilo.

2.3 Sri Lanka

In Sri Lanka, E-waste generation has been reported from domestic sources and imports. The country has prepared a preliminary inventory to highlight the extent of problem.

The country report for Sri Lanka, prepared by the Basel Convention Regional Centre, the People's Republic of China, states that E-equipment dismantling and reselling is a widespread business in Colombo. Some well-known markets are mainly Pettah, Panchikawatta, Wallewaththa, and Armer Street in Colombo. Further, there are vendors who collect discarded E-equipment from domestic users in repair shops and sell these to dismantlers and resellers. Dealers also import used computers and sell them to several resellers scattered all over the island. The total installed base/subscriber for mobile phones, personal computers, and TVs in 2005 in the country has been reported to be 1,151,764; 440,848; and 1,836,000, respectively.

In Sri Lanka, no E-waste dismantling facility exists in the formal sector. E-waste joins the existing general metal and plastic scrap stream, which is further dismantled and sent to domestic dismantlers and finally exported. According to the Metal Scrap Exporters Association, iron containing metals from scrap is separated into heavy metal and light metal. Metal parts in E-equipment are categorized as light metal. Plastic scrap including exported plastics are separated and chopped into small pieces using a special crusher and exported or sold to the local recyclers. Printed circuit boards (PCBs) and equipment casings are recycled through this method. There are two large steel recyclers in Sri Lanka and are located in Ja-Ela and Madampe. A small-scale recycler is

located near Colombo. According to the spokesperson for the scrap export association, their industry gives an income of about PRs1.5 billion per annum.

2.4 Other South Asian Countries

There are reports from newspapers and other published sources related to Bangladesh about E-waste generation and imports. However, there are no publications or reports for domestic E-waste generation and imports for Nepal, Bhutan, and Maldives.

3. POLICY, LEGAL, AND REGULATORY ISSUES

E-waste, being a new area of environmental concern, is a subject which requires sensitization and awareness at the policy, legal, and regulatory levels in South Asia. Though similar waste streams like MSW and hazardous waste are recognized and addressed in some form in the policy, legal, and regulatory regime of South Asian countries, E-waste is yet to be recognized and addressed as a waste stream. This is substantiated by the fact that no regulations specifically deal with E-waste in South Asian countries. Some E-wastes are controlled under the Basel Convention. Since the majority of South Asian countries are signatory to the Basel convention, the transboundary movement of E-waste mentioned in the convention can be regulated. However, this does not address the transboundary movement of all types of E-waste. Therefore, there is a need for regulations in each country to control E-waste generation and prevent its transboundary movement.

India has no specific regulation on E-waste. However, electrical and electronic assemblies are covered under category B-1110 of Schedule 3 of the Hazardous Waste Management and Handling Rules, 2003. Import of these wastes in India recycling or final disposal is not permitted. India has also well-defined MSW Management and Handling rules and regulations regarding recycling. In India, the MoEF/CPCB established a national-level task force to steer the E-waste initiatives in the country. E-waste manuals describing approach and methodology for inventorization of E-waste and its updating have been prepared. CPCB is preparing guidelines for environmentally sound management of E-waste in India. This includes development of guidelines for dismantling and recycling. E-waste inventory studies are under progress at Mumbai, Pune, and Bangalore.

In Sri Lanka, an activity plan has been prepared for tackling E-waste issues in the country. The salient features of this plan are given below:

1. Formation of a task force at the ministry for planning and implementation of E-waste activity plan;
2. Control importation of selected e-items such as computers and mobile phones, which have been used for 3 years to reduce potential waste generation;
3. Develop E-waste policy for providing framework for its management.
4. Introduce extended producer responsibility (EPR) for selected items;
5. Establish an efficient collection system for selected electronic waste;
6. Commitment for technical upgrade of selected registered recyclers for processing E-waste;
7. Assisting registered recyclers to obtain ISO 14001;
8. Streamlining E-waste recycling infrastructure by bringing them to the formal sector and building their capacity;
9. Formulation and institutionalization of E-waste tracking mechanism to update the inventory; and
10. Development of industrial estate for E-waste recycling.

No action plan or regulation related to E-waste has been reported in Bangladesh, Bhutan, Maldives, Nepal, and Pakistan.

The review of policy, legal, and regulatory frameworks in South Asia indicates that there is a need for a clear definition of E-waste, its classification into hazardous, nonhazardous waste or risky and nonrisky waste, and its coverage in the regulatory regime of each country. This will facilitate control at the local level in each country. This will further assist in developing harmonized E-waste codes among countries in the region to track and control its transboundary movement.

4. ASSESSMENT OF E-WASTE RECYCLING SECTOR/ROLE OF STAKEHOLDERS

In South Asia, some E-wastes are used as secondhand products, while some are dismantled for the recovery of precious/valuable metals. However, some parts from E-waste, which are not recycled and reused, are thrown

in open dumpsites or finally disposed by open burning. The assessment of E-waste recycling sector in South Asian countries indicates that recycling starts from the formal dismantling sector and moves to the informal recycling sector. E-waste movement from the formal to informal sectors is driven by trade and can be tracked by trade value chain. This E-waste trade value chain can be mapped based on material flow from the formal sector to the informal sector. An example of this chain mapped during the Delhi Study is shown in Figure 1.

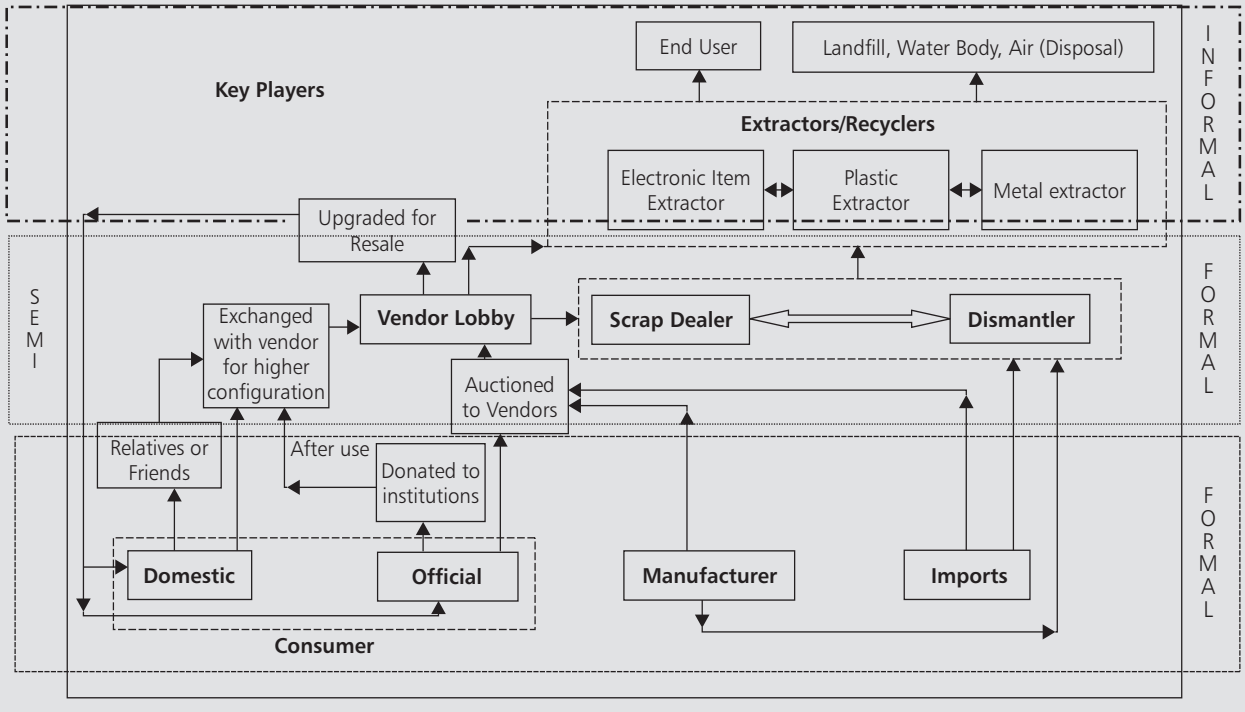
This chain was established considering the bottom-up approach with three levels of E-waste generation hierarchy. These levels of E-waste generation hierarchy give rise to three types of stakeholders:

(i) level 1—preliminary E-waste generators,
(ii) level 2—secondary E-waste generators, and
(iii) level 3—tertiary E-waste generators.

It is essential to understand the market governing this trade value chain. In case of the Delhi pilot study, the input to the first level comes from the formal organized market like manufacturers, importers, offices, and organized markets, where E-waste from domestic consumers comes either in exchange schemes or as discarded items. Therefore, the major stakeholders are scrap dealers/dismantlers who purchase E-waste from the first level in bulk quantities. They have limited capacity of dismantling and are involved in trading of E-waste with next level of dismantler/ scrap dealers. The market between the first and second levels is semiorganized (i.e., part formal) while the market between the second and third levels is completely informal. The major stakeholders between the first and second levels are scrap dealers/dismantlers who purchase E-waste from first level scrap dealers/traders and are involved in real dismantling of E-waste. These stakeholders have limited financial capacity and are involved in item/component-wise dismantling process and segregation, such as dismantling of CRT, PCB, plastic, and glass from E-waste. The major stakeholders between the second and third levels are metal extractors, plastic extractors, and electronic item extractors. They purchase item of value from dismantlers and use the extraction process, which are hazardous in nature.

The economics along the trade value chain drives the E-waste material flow. The movement of E-waste dismantling from the formal to the informal sectors intensifies its interaction with the environment, leading to environmental and health impacts. Metal extraction using acid process, open burning, and glass recovery from CRT breaking are very hazardous in nature. No scientific study in any South Asian country has established and quantified environmental

Figure 1: E-waste Trade Value Chain



Source: CPCB/ MoEF. Presentation of Delhi study. March 2004

and health impacts on account of formal and informal E-waste recycling. Published reports only highlight the existence of environmental problems related to E-waste recycling but the intensity and extent of problems related to recycling need to be established.

6. ISSUES, POSSIBLE SOLUTIONS, AND ROLE OF 3Rs FOR E-WASTE

Some major issues relevant to E-waste management in South Asia are inclusion of E-waste in the existing regulatory regime in each country and its transboundary movement. At the policy and regulatory levels, E-waste needs to be defined and brought under the purview of the existing regulatory regime. Therefore, there is a need to clearly define E-waste and its nature. The nature will determine its coverage under hazardous waste, solid waste, or any other type of waste. This will also assist harmonize E-waste codes as per regulatory regime in each country for the tracking and control of transboundary movement.

The inclusion of E-waste in the existing regulatory framework will also facilitate its management. This will enable the development of an efficient E-waste collection, transportation, recycling, and disposal system. This will require design and establishment of an E-waste recycling facility and related technology transfer. Technology transfer and adaptation are important issues especially recycling technologies for the first and second levels of dismantling and metal recycling. Companies producing electronic items can play an important role in facilitating the first and second levels of dismantling as part of their EPR. The existing capacity of metal extractors in the formal sector in the region needs to be assessed to facilitate metal recycling.

An environmental fee-based viable financial model for E-waste management can be developed, which should be supported by the regulatory regime. This can include the clean up cost of environmental damage caused by E-waste recycling. The institutionalization and implementation of this system requires integration of the informal with formal sectors. This can be achieved by making the informal sector part of the collection and transportation system. Such integration will also address the social issues related to E-waste collection, transportation, recycling, and disposal systems. Examples of collection and transport mechanism include "buy back" and exchange schemes, usage of existing retail mechanism for electronic items, transportation using existing MSW collection and transport mechanism, or transport network of retailers and manufacturing companies under the EPR.

The life cycle approach can be used for application of the 3Rs to E-waste. Early in the life cycle of an electronic item, reduction of an E-waste can be accomplished at three stages: product design, product manufacturing, and dismantling and recycling. The active life of electronic equipment can be increased by its refurbishment and distribution in the secondary market. The manufacturing companies can assist in increasing the life cycle of electronic equipment by refurbishment and promote its distribution and sales in the secondary market.

Research and development (R&D) leading to new technological interventions at the product design and manufacturing stages can assist to reduce and recycle E-waste. Examples of application of new R&D show usage of halogen-free components and lead-free soldering during the manufacturing process.

There is need to study the environmental and health impacts of E-waste recycling and development of E-waste inventory assessment, environmental impact assessment, and remediation guidelines. As part of these guidelines, an environmental management system (EMS) can be institutionalized at the dismantling stage in recycling facilities to promote pollution prevention and E-waste reduction. These guidelines may include those for proper segregation of E-waste at the first level of dismantling. This will assist in ensuring efficient downstream recycling. A compendium consisting of all the guidelines and best practices for environmentally sound recycling of E-waste should be developed for South Asia. Industry associations in collaboration with industries and R&D institutions can assist in developing these guidelines.

Increased awareness, training, and capacity building of all the stakeholders at each level of E-waste trade value chain both in the formal and informal sectors can promote E-waste management in South Asia. This should start with the awareness and capacity building of regulators/policy makers (customs/environment/other government institutions) for recognition of the problem and inclusion of E-waste in the regulatory regime in each country. This should be followed by awareness and capacity building of other stakeholders like collectors, dismantlers at each level, and formal and informal recyclers. NGOs can play an important role in awareness raising by organizing awareness campaigns and training workshops. Establishing an E-waste information clearing house in the region can play an important role for information dissemination in South Asia.

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Box 1: Session Summary
Session 4: E-Waste

INTRODUCTION

Session 4 started with a brief presentation showing snapshots of transboundary movement of E-waste, its status in South Asia and the resulting social and environmental impacts to set the background. This was followed by three presentations and a discussion session.

PRESENTATION 1: E-WASTE AS TRANSBOUNDARY ISSUE, Mr. Michikazu Kojima

Mr. Michikazu Kojima, IDE-JETRO, presented scenarios of transboundary movement of E-waste among Asia Pacific/South East Asia countries. The factors which drive the transboundary movement included regulatory environment, international trade in secondhand goods, and E-waste recycling infrastructure in different countries. Examples of transboundary trade of E-waste (e.g., photocopying machines, glass cullet both washed and unwashed) between the People's Republic of China; Hong Kong, China; Japan; Republic of Korea; Thailand; and Europe were presented. The mechanism of transboundary trade was explained in the context of hazardous and nonhazardous nature and its coverage under the Basel Convention. Examples of public-private partnership in Thailand were also highlighted during the presentation. The session concluded with specific recommendations to control transboundary movement with the institutionalization of adequate safeguards among trading countries. This included the application of schemes such as: different registration, prior notice and consent, prohibited and allowed scheme, and import tariffs scheme for E-waste among trading countries.

PRESENTATION 2: STATUS OF E-WASTE IN SOUTH ASIA, Mr. Amit Jain

Mr. Amit Jain gave a brief presentation on the sources (domestic/Imports) of E-waste generation in South Asia. The presentation highlighted the lack of recognition of E-waste as an issue in Bangladesh, Bhutan, Maldives, Nepal, and Pakistan. It was noted that E-waste is not covered in the regulatory/legal framework of South Asian countries. Existing and projected inventories of E-waste in India and preliminary inventory in Sri Lanka were also presented. Among South Asian countries, there are only two E-waste recycling facilities in the formal sector in India though the bulk E-waste recycling facility exists in informal sector. E-waste report on Sri Lanka prepared by the Basel Convention Regional Centre (PRC) indicates that E-waste joins the existing general metal and plastic scrap stream, which is further dismantled and sent to domestic dismantlers and exported. E-waste recycling trade economics from personal computers in Delhi indicated yearly sales turnover of $5 million during 2002–2003 with 10–20 % profit margin. The scrap recycling industry in Sri Lanka gives an income of about 1.5 billion Sri Lankan rupees (SLRs) per annum. The analysis of E-waste trade value chain in South Asian countries shows that E-waste material flows from the formal sector to the informal sector. This material flow from the formal to the informal sectors intensifies interaction with environment leading to environmental and health impacts. Some of the recycling processes like metal extraction using acid process, open burning, and glass recovery from CRT breaking in informal sector are very hazardous.

The major issues that were highlighted included regulatory/policy issues on the need to define E-waste,

its coverage in the regulatory regime of each country and its transboundary movement. The management technical issues included need for efficient collection, transportation, recycling and disposal system, design and implementation of E-waste recycling facility, and finally, technology transfer and adaptation. Economic issues included the development of a viable financial model for E-waste collection, transportation, recycling, and disposal. The social and environmental issues highlighted the need for integration of the informal sector with the formal sector and an assessment of environmental and health impacts of E-waste recycling. Finally, awareness, training, and capacity building of all stakeholders involved in E-waste trade are necessary.

PRESENTATION 3: ENVIRONMENTAL IMPACT OF IMPROPER RECYCLING OF E-WASTE, Prof. H. Wong

Prof. Wong presented the environmental and health hazards related to E-waste recycling, particularly melting of a circuit board, open burning of wires, and acid stripping of printed circuit board. It was informed that the recycling of E-waste through these processes leads to the release of hazardous toxins like PCDD/Fs, PBDD/Fs, PBDEs, PAH, PCBs, heavy metals like tin, and repairable suspended particles (RSP). Further, pollution due to E-waste in the food chain is researched. The case studies of Guiyu City and Taizhou City, the PRC were presented highlighting environmental and health impacts due to E-waste recycling in informal sector. It was informed that high levels of PCB, PAH, PCD/F, PCDD, PBDE in soils; PBDE in surface water; dioxin levels in air; lead levels in dust; and mercury in sediments have been reported in the vicinity of E-waste recycling facilities. Further, high levels of some of these toxins in fish, human hair ,and human milk have also been reported. The conclusions highlighted E-waste recycling facility in the informal sector grossly affects the land, air, and water environment leading to adverse health impacts.

DISCUSSION SUMMARY

Discussions started with the recognition of the problem in the context of South Asia. It was felt that the problem of E-waste could engulf the developing countries faster than the developed countries due to higher consumption induced by short span of goods used. The discussion focused on the definition of E-waste, its classification into hazardous, nonhazardous waste, risky and non risky waste, and its coverage in the regulatory regime of each country. It was recommended that this classification should be based on the regulatory mechanism of each country. However, a need for broader definition and classification of E-waste, which can facilitate its coverage in regulatory mechanism of each country and facilitate control of transboundary movement was identified. The need for harmonized E-waste codes among countries in the region was identified. An example of Nepal came up during discussion, where it was noted that there was no study in Nepal regarding E-waste. Moreover, it was informed that the problem of substandard electronic goods imports in Nepal exists and there is no regulatory mechanism to control it. Discussions also focused on recycling in the informal sector and the need for integrating the informal sector to formal sector. Further, the application of the 3Rs and other solutions were discussed.

Possible solutions included the development of environmentally sound guidelines and best practices for recycling, licensing system for recycling, and handling of E-waste (where informal sector handling and recycling should be restricted). It was recommended that the network of informal sector recycler should be tapped to develop efficient collection and transportation system for E-waste. This will also assist in integrating informal sector into the formal sector. EPR and take back mechanism should be used to strengthen the collection and transportation system of E-waste.

The need for technology transfer and adaptation with a demonstration project in any South Asian country was recommended. It was recommended that a 3R group should be formed to disseminate the application of the concept of 3Rs in the context of E-waste management to all stakeholders. At the same time, 3Rs can be used in E-waste management by applying EMS, ISO 14000, and occupational health and safety. An environmental fee-based viable financial model for E-waste management should be developed, which should be supported by a regulatory body. This should include clean-up cost of environmental damage caused by E-waste recycling. Finally, the session ended recommending capacity building of all stakeholders both formal and informal in South Asia.

CHAPTER 3

Promoting 3R Activities in South Asia: Priority Action Areas

3.1 Social Dimension

Dr. Martin Medina
Senior Policy Researcher, Kitakyushu Office
Institute for Global Environmental Strategies, Japan

1. BACKGROUND

Asia faces enormous challenges in managing its wastes. The region's rapid growth in its economy and population translates into increasing waste generation. The current urban population of about 1.5 billion will increase to 2.5 billion urban dwellers in 2020. More people and wealthier consumers will generate more wastes. The waste itself will change, increasing the percentage of packaging, such as plastics, paper, and metal in the waste stream. Asian countries already spend about $25 billion managing their wastes, which will increase to about $50 billion in 2025. However, most cities in the developing countries of the region do not collect the totality of wastes generated. In some cases, cities collect less than half of the wastes they produce. Even if the wastes are collected, the main disposal method is still by open dumping. Uncollected garbage and open dumps constitute sources of air, water, and land pollution, and pose risks to human health and the environment. Due to the lack of financial and qualified human resources, and sometimes the deficient regulatory framework, the management of solid wastes in Asia tends to deteriorate over the next several years. Urgent action is necessary to reverse this trend.

The social aspects must be clearly considered and are crucial to design and implement successful waste management and 3R plans and initiatives. Traditionally, waste management was seen as a mostly technical matter, and sanitary engineers made all major decisions. Over the past 30 years, however, experience has demonstrated that waste management in developing countries is a complex matter, and requires a multidisciplinary approach and team of specialists in diverse fields such as environmental education, marketing, community development, economics, city and regional planning, law, and civil engineering.

2. CONCERNS, OPPORTUNITIES, AND REQUIREMENTS

The main issues in the social dimension include community participation, the use of multi-stakeholder policy dialogues, the existence and prominence of the informal recycling sector, urban poverty, and gender issues.

Waste management and the 3Rs in Asia require solutions that promote community participation, create jobs, reduce poverty, improve industrial competitiveness, conserve natural resources, and protect the environment.

The main topics discussed at the meeting under this heading were the following:

- Informal sector sweepers, waste collectors, and pickers provide important employment and handle a significant portion of municipal waste, reducing municipal collection and disposal costs. They are generally not integrated into the mainstream economic system. They need access to loans, health protection, sorting space, social security, health care, and government support for their trade unions.
- Asia has the largest number of waste pickers in the world: about 1 million in India, and 1 million in the People's Republic of China's Pearl River Delta alone. Waste pickers are traditionally poor, neglected, ignored, or repressed by the authorities. Yet their work provides social, economic, and environmental benefits

to society. Waste pickers should be considered in design of waste management and 3R programs.

- Community-based recycling of household wastes is a multi-stakeholder process that can benefit the community as a whole and formalize involvement of the informal sector while reducing demand on the municipality. This requires close consultation with community officials and real involvement with all stakeholders, economic incentives, linkages with private business, and adequate infrastructure.
- There are significant health hazards in handling wastes, especially medical wastes and hazardous postconsumer wastes. Source separation and proper disposal of such wastes are needed, and collaborative efforts among small producers can provide adequate disposal infrastructure. Enforcement of regulations on disposal and possibly subsidy of infrastructure are needed to make proper disposal possible.
- Technical assistance is important in improving the working and living conditions of informal sector workers.
- Cultural and religious attitudes to waste should be considered when designing waste management plans.

3. PRIORITY ACTIONS

The working group identified the following areas that need special attention:

3.1 Use of Multi-stakeholder Policy Dialogues

a) For waste management and 3R programs, the participation of ALL key stakeholders is crucial.

b) Programs and initiatives often fail because affected stakeholders and communities are often not consulted and do not participate in the planning and implementation stages. Community participation can greatly diminish the NIMBY (not in my backyard) syndrome of opposition to the siting and operation of waste management facilities near their neighborhoods.

c) Cities cannot solve their waste management problems by themselves because they lack the necessary resources to do so. Cities need help from communities, the private sector, informal sector, researchers, and international organizations.

3.2 Attend the Informal Sector

a) Attend the needs of the informal sector by "cleaning" it, that is, improving the occupational health conditions under which waste pickers operate, thus, reducing the risks to their health.

b) Informal sector workers can help cities improve its waste management and 3R activities, particularly in public-private partnerships, microenterprises, and cooperatives.

3.3 Gender Issues

a) Women in the informal sector are often forced out when work income increases. Formalizing relationships and access to microloans can help women to maintain access. Experiences of other regions in microenterprises to generate employment should be examined.

b) Many children work as waste pickers, which can seriously affect their health and prospects for a better life. Children waste pickers often grow up to become adult waste pickers, perpetuating their poverty and marginalization. Child waste picker issues should be considered in waste management and 3R activities. Segregation of wastes at the household source can reduce the number of opportunities for waste pickers and thereby help to reduce child involvement as pickers.

3.4 Priority Wastes and Practices

a) Segregation of reusable and recyclable materials at the source is more desirable than posterior sorting, cleaning, and processing.

b) Organic wastes form a significant portion of municipal wastes. Municipalities should promote community composting, biogas generation, or methane production from landfills for local income. Composting does not generate methane (which contributes to global warming) and extends the life of landfills. Disposing of organic matter in landfills does generate methane, but, it can be recovered to produce energy.

4. SUPPORTIVE MECHANISM AND FRAMEWORK

To advance in improving the management of wastes and implementing 3R programs, change is necessary in various

areas. The working group identified the need to implement the following supportive mechanisms and framework.

4.1 Supportive Regulatory Framework

a) The regulatory framework at the national, state, and local levels should support the formalization of the informal sector.

b) Enforcement of transboundary regulations and standardized labeling of wastes and used products can help protect recyclers in developing countries.

c) Support and regulation of the informal recycling sector for E-wastes is needed to prevent dangerous small-scale recycling. Better cooperation and communication between the formal and informal sectors is needed and buyers up the supply chain should be required to provide assistance to small recyclers to make their processes safe. An Extended Producer Responsibility tax can be used to help small recyclers improve the safety of their processes.

d) Town planning and municipal resources should be committed to provide land for composting and segregation of recyclables.

e) Regulations can facilitate corporate social responsibility by supporting practices such as in Mexico, where industry donates recyclables to charities and waste picker organizations, who sell the materials for recycling. These donations are tax deductible for the industries.

4.2 Poverty Reduction

a) Solutions for waste management, especially in the informal sector, should create safe and stable jobs, not reduce them.

4.3 Risk Management

a) Some form of environmental reporting should be required to make the community aware of the risks they incur from industrial and medical wastes. Nongovernment organizations can play a key role in enforcing reporting requirements. Children reached through school programs can help make parents more aware of risks from wastes.

b) Segregation at the source is particularly important to prevent mixing of hazardous and nonhazardous wastes, as well as to prevent access of waste pickers to hazardous materials.

4.4 Partnerships

a) Partnership relationships should be developed between industry and community for better understanding of respective problems and possibilities for cooperation.

3.2 Economic and Financial Dimensions*

A.T.M. Nurul Amin
Professor of Urban Environmental Management
Asian Institute of Technology, Bangkok, Thailand

1. BACKGROUND

Huge business opportunities in 3R-related activities are growing in all South Asian countries because of the fundamental resource endowment reality of labor abundance and capital scarcity on the one hand and the emergence of affluent and large middle classes through economic development, urbanization, industrialization, and globalization. This is particularly evident in the resource recovery activities of the vast informal sector labor and enterprises (from primary collection point to open dumping sites), purchasing of recyclable wastes (primarily from households), and their selling activities (from secondary users to junk dealers and recyclers, including the informal sector workshops and formal sector manufacturing industries).

Another phenomenal development in this region is numerous entrepreneurial initiatives and successful demonstrations of many social entrepreneurs as to what is possible for 3R goals to succeed. Organizations such as Waste Concern and Pradipan in Bangladesh; SEWA and Civic Exnora in India; Waste Busters in Pakistan Environment Welfare and Recycling Program, Pakistan; and the Women's Environment Preservation Committee and Zero Waste Nepal in Nepal are some examples which have shown that 3R-related activities can be harnessed and developed into socially acceptable, economically viable, and environmentally sound business practices at least in the short- and medium-term perspectives.

The scale of such initiatives, experimentation, and demonstrations are however by definition too small for them to make an impact in so hugely populous countries of South Asia. Given the huge need and the demonstrated successes, the time is thus ripe now to institutionalize the successes for city, country, and regional coverage of 3R activities. A two-pronged institutionalization agenda is now necessary to sustain all the good work: (i) upscaling, through government/private sector involvement and instituting the provisions of incentives, regulations and (ii) education/awareness campaign for 3R—conforming behavioral change of individuals, households, businesses, and industries.

2. CONCERNS, OPPORTUNITIES AND CONSTRAINTS

While the informal sector activities have created a vibrant and dynamic waste economy in all cities, particularly visible in primate/capital cities of South Asian countries and significantly contributing to 3R goals, it is apparent that these are essentially poverty-driven and largely limited to domestic solid waste. The informal sector's involvement is, however, rapidly growing in E-waste. Its involvement in industrial and medical wastes is limited and should be completely stopped because of associated hazards. With economic growth, better income opportunities, and growing social concerns about health hazards, security, and welfare, the informal sector's role in 3R may get gradually diminished if not totally disappear as has happened not only in the developed countries but even in the newly industrialized economies (NIEs) of some South East Asian countries. To sustain the informal sector's role in 3R activities, thus, policy support will be necessary in South Asian countries as they grow economically and surplus labor declines.

Other than the long prevailing buying and selling of wastes by the informal sector and nonmarket mechanism of reusing wastes, the new generation of social entrepreneurs has demonstrated the scope of small-scale composting, composting under clean development mechanism (CDM) projects, landfill gas recovery under CDM projects, and recycling of plastic and used lead acid batteries.

* This contribution is based on the presentations and discussions in and recommendations of 3R South Asia Expert Workshop (30 August–1 September 2006, Kathmandu, Nepal) Working Group 2 comprising of A.T.M. Nurul Amin (AIT), A.H. Md. Maqsood Sinha (Waste Concern, Bangladesh), Dinesh Manandhar, (Development Network, Nepal), Amit Jain (India), Aida Karazhanova (UNEP-RRCAP), Bhai Raja Manandhar (government, Nepal), Kojima Michikazu, (Japan), Hideyuki Mori (IGES), Taku Ohmura (ADB), Rajasree Ray (government, India) and Sareen Vineet (JBIC). The first three served in the group respectively as chair, speaker and rapporteur.

The major barriers to succeed in seizing market opportunities in these are lack of (i) finance both for initial breakthrough, and more importantly, scaling-up stage, (ii) affordable/appropriate technology, and (iii) supportive policy environment.

The successful cases also suggests that two other key requirements to succeed are: (i) to be equipped with business plan and (ii) ability to forge partnerships with relevant government agencies (to get policy support), the private sector (for accessing well-established marketing channels), and donors and foreign direct investment (FDI) sources (so that access to financial resources can be established).

3. PRIORITY ACTION AREAS

For overcoming the major barriers in seizing business opportunities in 3R-related ventures, priority action areas identified include:

1. Creation of a 3R Promoting Fund at the international, regional, national, and city levels. The role of financial leverage can hardly be overemphasized. More concerted initiatives are necessarily similar to the Japan Bank for International Cooperation's (JBIC) Waste Management Projects. JBIC funding is still to be spread in South Asia. The Grameen Bank model can also be considered to support informal sector entrepreneurs in 3R-related activities.
2. In view of the centrality of waste separation at source for 3R to succeed, incentives, regulations, and education must be used simultaneously for ensuring optimal results in 3R practices and promotion. Provision of separate waste bins at the primary collection points is a must for facilitating waste separation.
3. Levying waste collection and disposal charge to all waste generating sources, preferably based on volume of waste, is important to reduce waste. Research and experience suggest that people are willing to pay when there is a correspondence between a service received and payment made for it.
4. Developing financing mechanism to access official development assistance (ODA) kind of support for the initial piloting and demonstration stage and international financial institutions (IFIs) funding and private sector investment—both domestic and FDI—for scaling up.
5. Financial and technical assistance for developing appropriate technology (cost effective, employment generating, and environmentally sound).
6. Marketing of compost and similar recycled products through well-established commercial/private sector marketing channels. Experience has shown that without tapping such channels 3R entrepreneurs, who are still largely social or civic entrepreneurs, on their own cannot market their products. Success stories also suggest the need to enhance nutrients of compost. For this, some research and development support has been necessary.
7. Partnership development with donors, IFIs, the owners, FDI sources, government departments and agencies, private sector, nongovernment organizations, community-based organizations such as the resident welfare associations (RWAs) in India, and media.
8. Lobbying for government support for allowing access to land and other essential services for doing business in 3R and ensuring policy support.
9. In the event of any market failure (e.g., with economic growth and development, the informal sector's involvement in 3R activities may start to diminish), market-based instruments such as subsidy may have to be used.
10. Provision of funding for providing protective gears to waste workers (including the informal sector) will reduce the health hazards associated with such work. This is not going to be a very costly program. Such programs will contribute to turning the informal sector work in 3R activities as "decent work" and thereby making them socially acceptable.

4. SUPPORTIVE MECHANISM AND FRAMEWORK

For some of the above areas of actions, 3R entrepreneurs themselves will have to take initiative. They on their own, however, can advance only up to a point. The one major reason that many 3R-related initiatives, innovations, and activities do not get replicated, multiplied, or upscaled is due to inadequate support from those who count (i.e., national government, local government, donors including ODA, IFI and FDI sources). With this in view key, supportive mechanisms for sustaining and upscaling the 3R practices need to be developed at all levels of public policy.

4.1 At the National Level

a) Subsidization of clean recycling technology and transforming informal sector work to decent

work, switching of subsidy from chemical fertilizer to organic compost, subsidy to preserve informal sector's involvement in 3R activities and to recycled material-using factories and industries;

b) Revenue generation through taxing polluting products and charging activities such as use of construction and demolition materials used for filling vacant land;

c) Introduction of Green Custom Charges on items with high disposal costs;

d) Greater use of deposit-refund scheme for bottle reuse;

e) Creation of positive and accommodative policy environment for the social, civic and private entrepreneurs related to recycling industries; and

f) Ensuring 3R-related education and awareness school curricula.

4.2 At the Regional and International Levels

a) Regional and international agreements on transboundary movement of hazardous waste, but not necessarily restricting economically beneficial trading;

b) Developed countries' funding and technical support need to be part of any transboundary movement of recyclables so that environmentally sound recycling practices can be promoted and ensured in all developing countries. Such support can be seen as technical assistance similar to well-established technical assistance provision for development projects.

4.3 At the Local Government Level

Greater use of ward committees/zonal offices in 3R activities. Because of the huge population in most South Asian cities, scale of waste management in general and 3R activities in particular need to be devolved and operated at a much smaller than the city scale. The municipal authorities ought to have willingness to charge for waste collection and disposal. The issues of level of charge and rate (flat or progressive) ought to be determined by involving the service receipients and assessing the willingness to pay and affordability to pay.

4.4 At the Community Level

Community and neighborhood organizations such as RWAs should be established and used for source separation activities for effective monitoring and promoting 3R-related activities. Such scale of operation and organizations are to be preferred in many instances than a city-scale operation so that they have the ownership and can serve as watchdog of 3R promoting activities at the neighbourhood level.

5. CONCLUSIONS

Although the focus here has been largely on economic and fiscal actions, supportive regulatory and institutional framework, environmental education and awareness programs, and media campaign and support are seen crucial complementary measures for obtaining optimal results from the use of economic and financial tools suggested above.

It is also to be noted that much of the 3R activities currently taking place in the region, particularly through the informal sector and social entrepreneurs, are mostly on municipal solid waste (MSW) and it has been rapidly growing in E-waste. Thus, issues discussed and action areas identified apply largely to MSW and E-waste, not with respect to industrial and medical wastes which can both be extremely hazardous. The South Asian countries are far behind in managing such hazardous wastes. For managing these wastes, South Asian countries need technical assistance and financial support. The knowledge and awareness of the scope, nature and extent of 3R promotion to the extent this is possible, with respect to industrial and medical hazardous wastes are still very limited in the region. Without overcoming this gap in knowledge, 3R activities cannot be comprehensive in the region.

Lest the key point will lose sight, let it be noted again that a lot has been going on in the region in turning waste into resource. Many of these have been spontaneous and poverty-driven. But, a qualitative change has been occurring now through the involvement of NGOs or social/civic entrepreneurs throughout the region. But, neither the role of the informal sector nor that of the social entrepreneurs can be counted upon for providing waste management service comprehensively (either area-wise or sectorally). Institutionalization of waste collection and disposal service provision and 3R activities based on all the good work is now ought to be the top priority. Otherwise, 3R activities will remain limited to pilot and demonstration projects.

For institutionalization and upscaling, the crucial need is money on the one hand and involvement of government and the formal private sector on the other. And they need to be supported by the international financial institutions and sources of foreign direct investment. Hopefully the 3R South Asia Expert Workshop in general and this report (on behalf of its Working Group which deliberated on economic and financial issues for promoting 3Rs) will contribute to make things fall in place for institutionalization and upscaling of all the good work in 3Rs in South Asia.

3.3 Technological Dimension

Surya Prakash Chandak, *Deputy Director, UNEP/DTIE/IETC*
and Hiroshi Nishimiya, *Deputy Director, UNEP/ROAP*

The working group was structured around sets of prepared questions as shown below. Not all were answered fully, but they did serve to stimulate a number of discussions, and in some cases more questions. To the degree that answers were found, they are described briefly following the sets of questions.

1. Need for technology:

What role does technology play?
What aspects of 3R implementation does technology support?

- Technology is a basic requirement and is required for all 3Rs.
- Both soft as well as hard components of technology need to be considered.
- All ground level implementation of 3R requires technology—be it soft or hard, or both.

2. Improving the access to and availability of information on technology:

What are the existing channels of information on technologies—media, established networks, technology suppliers, trade fairs, sectoral specialist institutions, etc.?
What is the reality in developing countries in terms of accessing those channels?
What type of technical information is required to facilitate the 3Rs?
What mechanisms need to be set and by whom?

- Establish channels for exchange of information from existing users in the region.
- Utilize the vendors of technology as information sources.
- Regional institutions should develop networks of stakeholders within the region and initiate collaborative training and joint research for regional projects on adaptive technology development.
- Civil society organizations (CSOs) can help identify local needs and options through networking with business and other civil society organizations.
- Establish local-level, multi-stakeholder groups for advising and monitoring local government performance.
- Better recycling type of technology is needed.
- Establish channels for information from existing users.
- Establish a national-level information dissemination system. Current systems are not effective, useful, or reliable.
- Business can contribute to technology development through problem identification, support of pilot testing of technologies, and sharing of knowledge and experience with research and development (R&D) institutions and civil society organizations.
- R&D institutions should adapt appropriate technologies to local conditions and requirements. This can be done through funding by partner institutions and through partnerships of government with industry. Partnerships with NGOs and student exchange programs may also contribute.
- We need more efficient specific technology to produce ethanol from agricultural wastes.
- We need technologies for recycling agricultural and household wastes to bioenergy. Organic house wastes can be turned into bio-energy such as ethanol and biodiesel fuel (BDF), and waste cooking oil can be converted into BDF.

3. Supporting framework:

What are common and specific features of South Asian nations?
What do countries need in order to develop and implement appropriate policy instruments?
What are essential elements to conduct policy and what policy instrument would be useful?

- National government should provide a policy framework conducive to technology development and effective project implementation.
- Transfer of experience among nations is needed of what has worked or not.

- A stakeholder consultation process and identification of issues are required.
- Raise the awareness of local government to technological options for waste management and build a supporting local-level institutional framework.
- Increased and specific accountability under technical and financial support programs is needed.
- More recognition is needed of local conditions and aspects.
- Institutional capacity building for policy development is needed.

What are existing gaps in capacity building and what are the priority areas?

What are the most effective ways to build capacity at the national and local levels?

- International institutions can provide financial and technical support to build technical capacity to manage wastes, including events and travel to provide participants with the opportunity to learn and share experience from different nations and regions.
- Build pre-advisory services for entrepreneurs.
- Build regional and national technology assessment capability, thorough developing regional or national knowledge hubs.
- There is a mismatch between capacity building recipients and their actions and responsibilities.
- Greater emphasis should be placed on building capacity in other stakeholders—nongovernment organizations (NGOs), community-based organizations (CBOs), industry associations, and the academe.
- An intercountry project-based network should be developed.

4. Financial requirements:

What magnitude of financing is required?
What could be possible sources of financing (e.g., JBIC, etc.)?
What role can financial institutions, development banks, commercial banks, and government play?
How can the availability of financing and a country's ability to access or attract financing be improved?

- 3Rs require investment funding and not a total cost, as do end of pipe technologies.
- A concerted effort must be made to change the perspective on waste management to be an integral part of the manufacturing process and to be an investment opportunity rather than a sunk cost.
- Supportive economic instruments should be explored.

Salient Features

Responsible Agencies	Action
Government • **National** • **Local**	- Provide a conducive policy framework including built-in mechanisms to ensure effective implementation. - Build supporting local-level institutional framework - Raise awareness by local government - Establish local-level, multi-stakeholders groups for advising and monitoring local government performance.
International institutions **Regional institutions**	- Provide financial and technical support for capacity building - Additional events to provide participants with the opportunity to learn and share experience with each other - Develop network of stakeholders within the region and initiative collaborative training and joint research regional projects
R&D Institutions	- Develop and adapt locally suitable technologies. - Provide funding for R&D by partner institutions - Build industry + R&D institution partnerships - Support inter-NGO partnerships - Promote student exchange programs
Business	- Identity problem - Support pilot testing of technologies - Share knowledge and experience with R&D institutions and CSOs
Civil Society Groups	- Networking and partnership among civil society groups.