3R in Asia

a gap analysis in selected asian countries

3RKH
Reduce, Reuse, Recycle

Reduce Reuse Recycle

3R Knowledge Hub

AIT
ASIAN INSTITUTE OF TECHNOLOGY

supported by: ADB

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Reduce Reuse Recycle

Rapid economic growth is accompanied by a corresponding rise in resource consumption and environmental degradation. As estimated by the World Bank in 2004, urban authorities in Asia spend 50-70% of their revenues on waste management and the effect of neglecting the environment costs an average of 5% of the GDP...

Foreword

Solid waste generation and its management is being widely debated across the world in various events, from local forums to international conferences and summits. Solid waste management has become a niche spot in the recent years. Technology providers, research institutes, academicians, manufacturers and consumers have joined hands to offer economically viable, socially acceptable and technologically sustainable solutions. Managing solid waste cannot be single-handedly done by the smallest administrative unit of a town or even by the federal government. It has to be a concerted effort of all the stakeholders; from waste generators to municipal administrations to technology providers.

Realizing the need for cross-sectoral participation and the diverse roles of stakeholders, the 3R Initiative was proposed by the Japanese Government aiming to build a sound material-cycle society through the effective use of resources and materials. Gaining further momentum, it was agreed as an Initiative of the G8 during the Sea Island Summit in June 2004. Since then, the Initiative had taken several forms and shapes through a line of events such as the 3R Ministerial Conference hosted by the Government of Japan in April 2005 and the Senior Officials Meeting on 3R in March 2006.

Reaffirming the role of 3Rs as a strategic solution to the waste crisis, the Asian Development Bank decided to establish the 3R Knowledge Hub (3RKH) through its "Technical Assistance for the Establishment of Regional Knowledge Hub". The 3RKH is jointly hosted by United Nations Environment Programme, Regional Resource Centre for Asia and the Pacific and Asian Institute of Technology in collaboration with the United Nations Economic and Social Commission for Asia and the Pacific and United Nations Environment Programme, Regional Office for Asia and the Pacific. Situated in the sprawling campus of Asian Institute of Technology, the 3RKH functions with specific objectives on growth of identified 3R knowledge and technologies and disseminating the same to a wider audience.

This report, a landmark research product of the 3RKH, aims to present the prevailing technology, management and policy gaps to 3R implementation in selected Asian countries. The core contents of the report analyze at depth the currents on how waste is managed. Looking at the threats and widespread nature of the issues, the report focuses specifically on urban municipal waste, healthcare waste and e-waste. The report addresses the comprehensive chain of action on the management of waste from collection to final disposal and the treatment technologies adopted at various stages. With an understanding that management and policy measures are equally important in addressing waste related issues, the report discusses the current scenario in these aspects as well. Finally, the report places specific recommendations to the stakeholders thus enabling them to move towards a sound material-cycle society, as envisioned by the forerunners of the 3R activities.

Though the focus countries of the 3RKH are primarily from Asia, we trust that the 3RKH contributes to promoting 3R in a wider scope of countries by working together with partners and providing knowledge services for a resource efficient and environmentally sustainable society.

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Preface

Reduce, Reuse, Recycle Knowledge Hub (3RKH), under the patronage of the Asian Development Bank, aims to support and strengthen Asia-Pacific's regional capacity on generating innovative development concepts and technologies on 3R in developing Asian countries and to promote networking for knowledge dissemination. The 3RKH aims to mainstream new concepts on 3R in innovation, science, technology, management development, and related fields for the region and to promote information exchange.

Amidst other activities, the 3RKH conducted a research with the objective of identifying the gaps in implementing 3R-oriented solutions for waste management. The research and its outcomes were documented in the form of a report. The first draft of this report was presented during the 3RKH Inception Workshop, 7th Asia Pacific Roundtable for Sustainable Consumption and Production at Hanoi, Viet Nam in April 2007. More than 60 delegates from governments, industrial sectors, development agencies and academic institutions took part in this event. Additional information and review comments were solicited from the country representatives and incorporated in the report.

This report, titled "3R in Asia – A Gap Analysis in Selected Asian Countries", discusses the prevailing situation in managing urban municipal waste, healthcare waste and e-waste for 15 countries in the Asian continent, including developed nations such as Japan, Korea and Singapore. The developing countries considered for the study are Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia, Laos, Malaysia, Philippines, Thailand and Vietnam. The report also discusses the priority areas of concern for each country according to the surveyed data and the status of 3R technology.

The research indicated that no previous study has been carried out with specific focus on 3R implementation, policy issues and technology status. Therefore, this report is expected to be a good start in providing impetus to enhance the existing good practices and assist in planning technology support and capacity building in developing countries.

On behalf of the team, I take this opportunity to thank ADB for sponsoring this project and AIT for providing all the necessary support. We would like to extend our deep gratitude to all agencies, organizations and individuals who have directly or indirectly contributed to the development of this report. Our special appreciations are expressed to Mr. Marc Ruffet and Mr. Anthony D'Agostino, UNEP ROAP and Ms. Regina Cheah, Global Environment Centre, Malaysia for critically reviewing this report.

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Executive Summary

Waste generation and its appropriate management have become widely-debated issues across the world. Technology providers, academicians, research institutes, governments, and businesses have joined hands in many ways to solve the waste crisis in an environmentally efficient manner. Overall waste management measures direct responsibilities to both upstream producers and downstream consumers. It is only the composition and amount that varies, but the magnitude of the problem remains the same or at least on a common scale, meaning that everyone in the society has common but differentiated responsibilities.

Until recent years, methods of waste management and disposal were merely looking at 'disposal or getting rid of'. With compounding problems of decreasing landfill and dumpsite areas, alternative methods need to be adopted to reduce the volume of waste generated. Above all are the rapidly depleting resources, fuel reserves, minerals and ores. Comprehensive solutions, taking into consideration the stress posed on the environment and ecosystem, is essential to ensure sustainable development.

The 3Rs - Reduce, Reuse and Recycle - are observed to be the buzzwords of waste management in the developed countries of the present day. This book aims at presenting to a wider audience the results of the study conducted on analyzing the technological, management and policy gaps in implementing the 3Rs of waste management in some Asian countries.

The gap analysis was performed for 15 countries in the Asian continent, including developed nations such as Japan, Korea and Singapore. The developing countries considered for the study are Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia, Laos, Malaysia, Philippines, Thailand and Vietnam.

Evidently, the developed countries have achieved remarkable progress in implementing 3R. With the favorable cooperation of government and policymakers, these countries have been able to visualize and achieve positive milestones in 3R. Most of the waste management options have 3R principles underlying in it thus fostering its development. Though not deliberate, some of the measures have yielded tremendous results in this group of countries.

The developing countries considered in this study demonstrate enormous scope for improvement as far as waste handling and management is concerned. Most of these countries do practice the 3Rs of waste management, not as an organized and formal way of waste management, but as a means of livelihood, either by waste scavenging or down cycling of segregated solid waste. Clearly, in all these countries, the 3R are still informal. Lack of awareness of environmental and health issues, absence of technological guidance and zero policy and legislative support are some of the speculated reasons for mushrooming of such informal sector operations.

Technology transfer, awareness raising, community participation, public private partnerships and above all, efficient and effective outreach of research initiatives on 3R are vital to move towards a sound material-cycle society.

Acronyms & Abbreviations

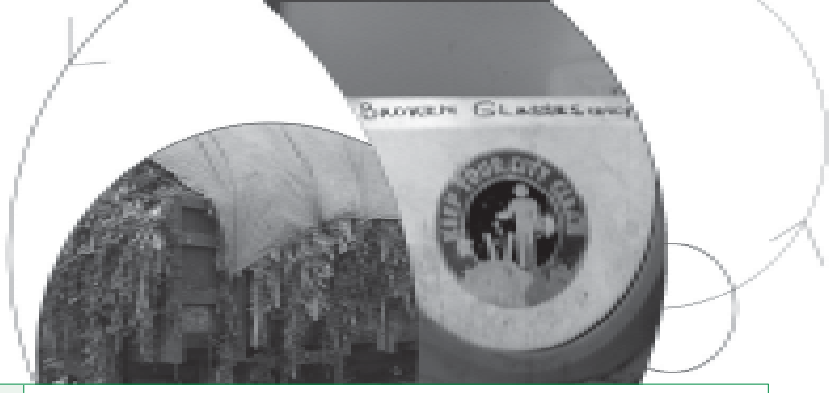
3R	Reduce, Reuse, Recycle
ACHR	Asian Coalition for Housing Rights
ADB	Asian Development Bank
AFSB	Alam Flora Sdn Bhd
ASEAN	Association of South East Asian Nations
AWP	Army Welfare Project
BHU	Basic Health Unit
BCRC-SEA	The Basel Convention Regional Centre for South-East Asia
BMA	Bangkok Metropolitan Administration
CDM	Clean Development Mechanism
CIDA	Canadian International Development Agency
CPCB	Central Pollution Control Board
CRT	Cathode Ray Tube
CSARO	Community Sanitation and Recycling Organization
DANIDA	Danish International Development Agency
DCC	Dhaka City Corporation
DoH	Department of Health
DPC	Department of Public Cleansing
DPH	Department of Public Hygiene
DPWT	Department of Public Works and Transport
ECoP	Environmental Code of Practice
EPR	Extended Producer Responsibility
EU	European Union
GDP	Gross Domestic Product
GNP	Gross National Product
GoM	Government of Malaysia
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Technical Cooperation)
HW	Hazardous Waste
HWMS	Healthcare Waste Management System
ICPE	Indian Centre for Plastics in the Environment
ISW	Industrial Solid Waste
ISWM	Integrated Solid Waste Management
IT	Information Technology
IWM	Integrated Waste Management
JDWNR	Jigme Dorji Wangchuck National Referral
JICA	Japan International Cooperation Agency
JSWME	Japan Society of Waste Management Experts
LCD	Liquid Crystal Display
LDPE	Low Density Poly Ethelyne
LGUs	Local Government Units
MDGs	Millennium Development Goals
MoE	Ministry of Environment
MoH	Ministry of Health
MoWHS	Ministry of Works and Human Settlement
MPP	Municipality of Phnom Penh

Acronyms & Abbreviations

MRF	Material Recovery Facility
MSME	Micro, Small and Medium Enterprise
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NCPAP	National Cleaner Production Action Plan
NEA	National Environmental Agency
NEC	National Environment Commission
NGO	Non Governmental Organization
NIP	Neighborhood Improvement Program
NISTPASS	National Institute for Science & Technology Policy and Strategy Studies
NORAD	Norwegian Agency for Development Cooperation
OECD	Organization for Economic Cooperation and Development
ORC	Outreach Clinic
PBB	Polybrominated Biphenyls
PBDE	Polybrominated Diphenyl Ethers
PCD	Pollution Control Department
PDF	Plastic Derived Fuels
PET	Polyethylene Terephthalate
POY	Partially Oriented Yarn
PPWM	Phnom Penh Waste Management
PULPAPEL	Philippine Pulp and Paper Association
RDF	Refuse Derived Fuel
RGoB	Royal Government of Bhutan
RSPN	Royal Society for Protection of Nature
SEPA	State Environmental Protection Administration
SHAR	Specified Home Appliance Recycling
SPCB	State Pollution Control Board
SWM	Solid Waste Management
SWMSB	Southern Waste Management Sdn Bhd
ULAB	Used Lead Acid Battery
UNCRD	United Nations Centre for Regional Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
URENCO	Urban Environment Company
US-AEP	United States-Asia Environmental Partnership
VEM	Vietnam Environment Monitor
VNCPC	Vietnam Cleaner Production Center
VPC	Vietnam Productivity Center
WEEE	Waste Electric and Electronic Equipments
WHO	World Health Organization
WNA	Waste Not Asia
ZKK	Zero Kalat sa Kalinisan

Contents

The emerging consumer society has brought forward an enormous challenge of managing modern waste and developing a 3R society to the municipal authorities troubled with issues in waste management and sanitation...



chapter 1
Introduction

Enormous challenges in developing a sound material cycle society in Asia is revealed by the extraordinary emerging waste generation statistics from the region as it rapidly industrializes. Unfortunately, this growth is also accompanied by a corresponding rise in resource consumption and environmental degradation. As estimated by the World Bank in 2004, urban authorities in Asia spend 50-70% of their revenues on waste management and the effect of neglecting the environment costs an average of 5% of the GDP.

A recent fact sheet on China's Environmental Health Project predicts that Beijing alone will produce domestic e-waste at an alarming 115,000 tons comprising of 3.6 million old televisions, refrigerators, washing machines, computers and air conditioners, and 2.3 billion mobile phones. It is also expected to exceed 158,000 tons by 2012. China is also expected to account for 24% of the world steel production thus leading to a massive growth of the secondary sectors. These developments have in many forms, compelled the industries and responsible parties to sideline environmental issues.

India on the other hand is equally playing hard. Data captured through Market Supply Method for 2004-2005 reveals an estimated market size of personal computers at 15.4 million, television sets at 11.7 million, refrigerators at 4.8 million and washing machines at 1.7 million. The study also estimates a 25% growth rate of computers and 15-20% of other items annually.

Accordingly, with respect to the obsolescence rate and e-waste inventory, domestic e-waste in India is estimated to be around 146,000 tons and expected to exceed 1.6 million tons by 2012.

Sadly, for both China and India, these figures do not include e-waste that are shipped from developed countries. The current pace of urbanization, the consumerist society and its waste generation will lead us to a point of no return, let alone global sustainability and poverty reduction. This emerging consumer society has brought forward an enormous challenge of managing modern waste and developing a 3R society to the municipal authorities troubled with issues in waste management and sanitation.

Junichiro Koizumi, the former Prime Minister of Japan proposed the 3R Initiative at the G8 Summit held at Sea Island in 2004 and was endorsed by the G8 leaders. Later that year, the 'Ministerial Conference' to formally launch the 3R concepts was held in Tokyo from 28-30 April 2005. The launch is considered as the first step to change global consumption and production patterns to build a sound material cycle society. Since then, there have been significant developments and awareness on 3R initiatives in most of the Asian countries.

Although some governments have recently formulated and incorporated 3R measures and cleaner production options to tackle the waste crisis, most of them have been implemented only in the national capital cities. In rural and peri-urban areas, urban municipal wastes generate a steady income despite the risks involved in treating and down cycling them to other consumer products. Looking back in time, Asian societies, especially in the villages, have been leading a 3R-oriented lifestyle. Traditional know-how on resource conservation has been

Urban residuals or Shifting cultures?
Image source: www.3rkh.net

passed on from father to son. These techniques now remain useless when confronted with urban waste. These sudden shifts in the culture have brought along various challenges and chaos in solid waste management. It also makes clear the fact that the "business-as-usual" scenario cannot continue in Asian countries as long as the current waste disposal and treatment system prevail.

These compounding wastes grimly remind all stakeholders to adopt and implement 3R initiatives at both-ends, upstream production and downstream consumption. Executable and feasible technology frameworks should be developed. Prior to that, studies should be conducted to assess the gaps and prevailing treatment situations.

This report attempts to give a broader picture of the ongoing 3R implementation in some Asian countries. Wastes from three major sources (urban municipal waste, healthcare waste and e-waste) have been considered. This report does not discuss or comment on any policy dialogues referring to Transboundary Movement of recyclable or hazardous waste but might use some figures to elaborate the scale of recycling and downcycling operations in the developing countries. It is prepared with the full intention of identifying the break points or gaps that result to wide spread informal activities and practices.

It was observed that in most of the studied countries, informal activities highly dominate due to lack of funding, government initiation, lapse in policy and public ignorance on waste management issues. Weak activities (for livelihood purposes) adopting primitive technologies and operating in a haphazard manner at the micro and meso scales are common. Unlike those in developed countries, certain waste treatment technologies are insignificant in the study countries and have proved to be a failure due to level of maintenance, public opposition, operating budget and waste composition.

Country Highlights in Promoting 3R Initiatives

China: China has been promoting policies blending market promotion, regulatory control and public participation for the development of a circular economy, with cleaner production and waste management integrated into legislation. Progress has been made in pilot projects at the industrial level, industrial demo-parks and construction of circular economy pilot provinces and cities.

India: Policies and strategies are designed to resolve conflicts arising between developmental and environmental goals. The draft National Environment Policy of 2005, which incorporates the concept of the 3R, is currently under consideration.

Indonesia: Major issues regarding waste include a lack of awareness, limited budgets, lack of compliance, and limited access to waste treatment facilities for micro, small and medium enterprises. A coherent national strategy is seen as essential to enhance coordination, synergy, efficiency and effectiveness.

Japan: Japan has made substantial progress in achieving greater recycling rates while reducing its final disposal amount. Japan has carried out several initiatives to promote the 3R such as the establishment of grants at the local level, amendment of the "Containers and Packaging Recycling Law," and launching a multi-stakeholder forum for the promotion of 3R activities.

Malaysia: "The National Recycling Programme 2000" was launched and "The National Strategic Plan for Solid Waste Management 2005" is currently being finalized. Waste minimization is recognized as one of the priorities in Malaysia. Strategies are built on three pillars: enhancement of awareness, strengthening of partnerships and development of institutions.

The Philippines: "The Ecological Solid Waste Management Act" specifies the following activities: (1) achievement of a recycling rate of 25% or above by 2006 and increasing thereafter, (2) segregation at source and collection, (3) establishment of material recovery facilities, (4) eco-labeling, (5) green procurement.

Korea: The following have promoted a sound material-cycle economy: (1) volume-based waste fee, (2) EPR, implemented with mandatory targets for product recovery and recycling, (3) regulations for promoting recycling of construction waste, (4) reduction of food waste.

Singapore: Singapore's strategy towards Zero Landfill and Zero Waste includes (1) volume reduction through incineration, (2) promotion of recycling in industry and in the community, (3) the reduction of waste going to landfills and (4) promotion of reusable bags to reduce usage of plastic bags and introduction of a packaging agreement.

Thailand: Thailand has developed a national integrated waste management plan. 3R activities have progressed substantially among industries, NGOs, and civil society. Various international technical cooperation programs are being implemented. Thailand has several good practices addressing the 3R, including take-back schemes for end-of-life products, waste exchange programs and a green purchasing network.

Vietnam: The Law on Environmental Protection addresses the import of scrap materials, economic instruments including preferential taxation, technology transfer and promotion of environmental industry. "The National Strategy for Environmental Protection" set various targets for 2010 and 2020. The National 3R Strategy is being developed in collaboration with JICA, UNCRD, IGES, Ministry of Environment of Japan and ADB.

Source: Compiled by the Ministry of the Environment from the documents of Senior Officials Meeting on the 3R Initiative

identify the gaps in both technology and management aspects on the implementation of 3R...based on both qualitative and quantitative information supported by concrete evidences of prevailing practices in waste management...

chapter 2
Methodology

The objective of the analyses was to identify the gaps in both technology and management aspects on the implementation of 3R in the selected countries. These analyses were done based on both qualitative and quantitative information supported by concrete evidences of prevailing practices in waste management, especially, urban municipal waste, healthcare waste and e-waste.

Conducting a gap analysis for the implementation of 3R broadly involves the following stages:

1. Obtaining country specific information on waste management practices, focusing on Reduce, Reuse, and Recycle aspects.

2. Collecting information on waste characteristics, composition, generation, private sector involvement in collection, transport and disposal systems.

3. Identifying priority areas for action based on available information.

4. Preparing a list of available technologies common in all countries and mapping the country specific results with it.

5. Collecting and consolidating management related information such as policies and regulations, international initiatives, mechanisms for awareness raising etc.

6. Subjective evaluation of the present waste management status compared to those being currently used in some developed countries.

7. Comparing the technology management related aspects on a common platform on par with the developed Asian countries.

The countries chosen for the study were grouped into three categories based on their best available waste disposal technologies, relevant policy measures and enforcing regulations.

1. Japan, Korea and Singapore form the group of developed Asian countries with good practices of waste management in terms of implementation efforts, policies and relevant legislations.

2. Bangladesh, Brunei Darussalam, China, India, Indonesia, Malaysia, Philippines, Thailand and Vietnam form the group of developing Asian countries systematically planning to achieve better waste management through progressive policies and plans.

3. Bhutan, Cambodia and Laos are the aspiring nations looking forward to proactive policies and waste management measures.

For example, Japan, Korea and Singapore have direct legislations enforcing recycling and reuse of discarded materials.

Similarly, in Bangladesh, legislations preventing the use of plastic carry bags are strong. On the other hand, Bhutan and Cambodia, have been trying to provide a conducive setting to promote better waste management practices.

Overall, it could be noted that the developed Asian countries are one-step ahead in terms of implementing what the other countries have been envisaging. Though this sends a positive signal from the perspective of progress, a gap in achieving the desired goals exists.

INFORMATION SOURCES

Owing to the sensitivity of the gap analysis and its likely impacts on future decisions, the choice of data and information sources were limited and restricted to those considered official or are endorsed by the respective governments. The main source of documents for the Gap Analysis were those presented and circulated in the various line of events on the 3R, such as the:

- Ministerial Conference on the 3R Initiative April 2005, Tokyo, Japan
- 3R Senior Officials Meeting, March 2006, Tokyo, Japan
- 3R South Asia Workshop, August 2006, Katmandu, Nepal
- Asia 3R Conference, November 2006, Tokyo, Japan
- 3R South East Asia Workshop, February 2007, Manila, Philippines

In addition to the above conference proceedings, websites of the respective national governments, multilateral agencies and line organizations provided reliable information for use in the gap analysis. Reports of Government Agencies and Departments were also referred to cross-check the validity of the information obtained from other sources. The valuable contribution of published literatures in Journals, Periodicals and Policy Briefs was of great use in obtaining regional information and the perspective of regional experts and researchers on 3R. Documents and reports of Regional and International NGOs provided critical perspectives of the current situation.

STRUCTURE OF COUNTRY REPORTS

The country reports have been designed to first provide an overview of the country by presenting some macro-economic information to provide a general picture.

The next section of the report discusses the identified priority areas for waste management. The following priority areas identified vary at large: urban municipal waste, healthcare waste and e-waste. Eventually, the priority areas have been identified rationally, based on the severity of the problem, nature of threats, prevailing situation and current practices in tackling the issue. The reason for presenting the priority areas is to bring light to other wastes that have been posing threats.

The subsequent sections of the report, containing the gap analysis are structured to present the status of the situation. An analysis of the status evokes various thoughts. The findings at the end of each waste sector discuss these thoughts in a systematic manner.

Following the results of the analysis, an evaluation of the status was done to crystallize the results and present it in a form easy to understand and interpret. This was done by displaying the results in a tabulated form. Both prevailing technology and its appropriate management are essential for successful implementation. Considering this, two tables were designed to present the information and reflect the findings in an understandable way.

DESCRIPTION OF LEGENDS USED IN THE TABLES

TECHNOLOGY ASPECTS

Formal and Informal denote the existence of regulations, laws and rules to govern an activity.

An activity is said to be Formal, if it has specific laws and rules that mandate, enforce, encourage and allow the activity within a specified regulatory framework. For example, the National Recycling Program, 2001 targeting urban municipal waste is backed by the government's policies. As a spin off, many activities originating from this Program have contributed to the overall recycling rate in the country.

An Informal activity is one that does not have any law, rule or guiding policy, still the activity might be happening by itself. For example, sorting of urban municipal waste in India is a source of livelihood for many scavenging communities. Yet, there are no regulations or laws to safeguard the interests of these communities. These activities happen regardless of the governing regulations and hence making them informal activities.

Strong and Weak represent the level and scale of a particular activity.

A Strong activity is one that is carried out at full swing such as an independent business. In this case, the activity, in most of the cases uses state-of-the art technologies. For example, in Japan, material recovery from e-waste is an activity that has received impetus from the private sector. Organized and professionally managed enterprises, with appropriate technologies make them an independent business sector.

A Weak activity represents one that is carried-out at micro and meso scales, often for livelihood purposes. Weak activities generally use primitive technologies and often operate haphazardly. In Bangladesh, for instance, recycling of used lead acid batteries is an activity that has a policy underway. In most cases, the recycling is done in a haphazard manner. The level of technology and the scale of operations adopted make it a weak activity.

Where no law or rule exists and the practice is totally absent, it is assumed to be a gap.

Accordingly, any 3R-related activity can be positioned based on their formal, informal or strong and weak nature.

In the Philippines, the reported voluntary initiatives, adequately address 3R-oriented measures, but may not be deliberate. The current voluntary initiatives are considered sufficient to effect the shift towards 3R.

Insufficient denotes that the particular aspect partially addresses 3R, but may not be enough to initiate 3R-oriented activities. In Malaysia, for example, the prevailing management measures are not adequate to implement 3R.

Ideally, a Gap, denotes a missing aspect that is considered essential to initiate 3R-oriented activities.

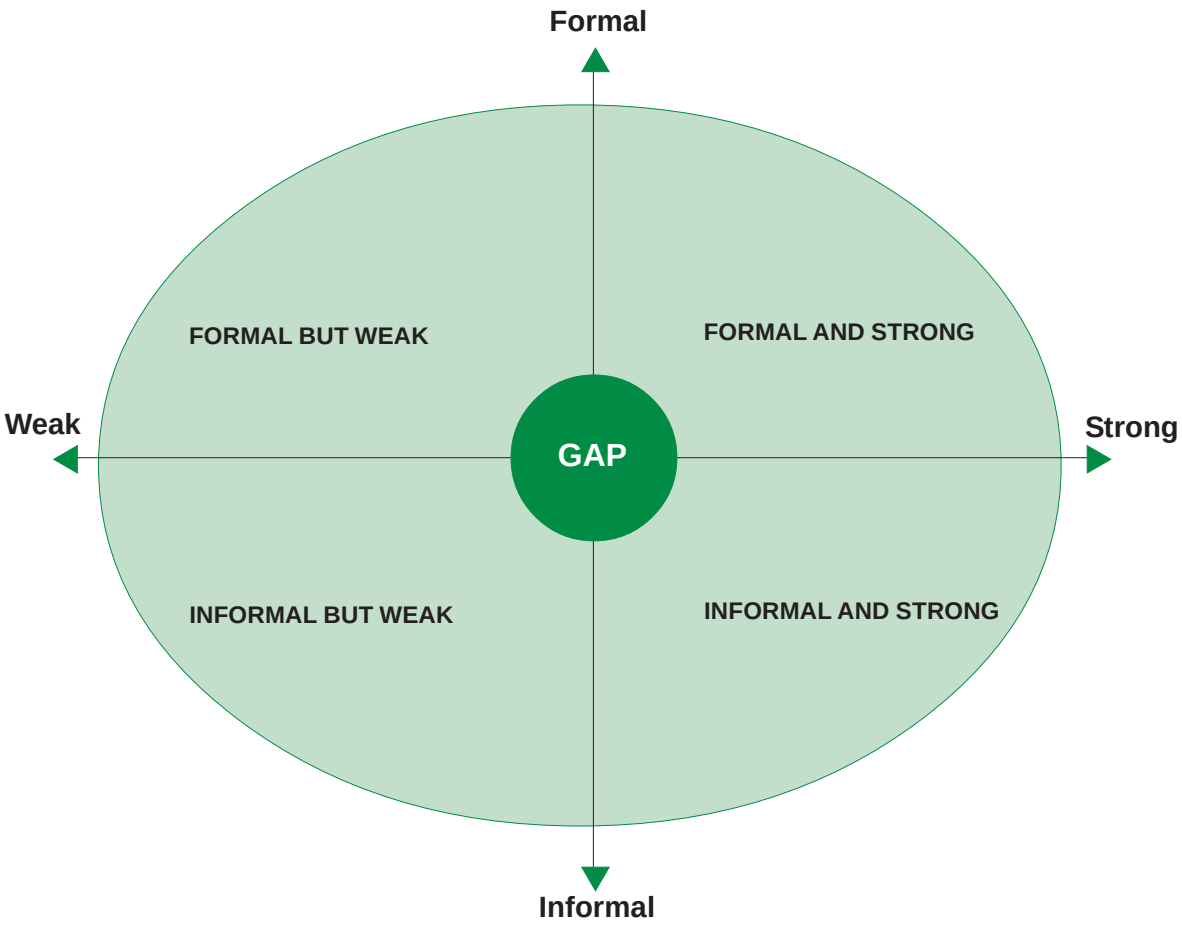


Illustration of legends in the Table

Bangladesh faces a serious problem in managing its pollution crisis. With the present population density of 1500/km^2, one of the highest in the world, Dhaka City faces serious problems in tackling waste issues. For instance, in the low-lying areas of Bangladesh, clogging of sewer systems and storm-water drains during heavy floods is due to the haphazard disposal of waste...

chapter 3
country analysis

3.1 Bangladesh

BACKGROUND

Bangladesh has a population of about 150 million living on a land area of about 145,000 km^2. Despite sustained domestic and international efforts to improve economic and demographic prospects, Bangladesh remains an impoverished and overpopulated nation. However, the country has managed to achieve a per capita GDP of about USD 2,200. Although more than half of the GDP is generated through the services sector, nearly 30% of the people thrive on agriculture.

Major impediments to growth include frequent cyclones and floods, inadequate port facilities, a rapidly growing labor force that cannot be absorbed by agriculture and insufficient power supplies. The country, striving to achieve economic stability, is pressed by various issues from different angles. One of the key issues in the country is waste management. The country often has deficit national budgets preventing the implementation of waste management initiatives at a large scale. In Dhaka, especially, problems from solid waste are very acute compared to many cities of the developing countries.

PRIORITY AREAS

Bangladesh faces a serious problem in managing its pollution crisis. With the present population density of 1500/km^2, one of the highest in the world, Dhaka City faces serious problems in tackling waste issues. For instance, in low-lying areas of Bangladesh, clogging of sewer systems and storm-water drains during heavy flooding is due to the haphazard disposal of waste. Threats to public health from the disposal of municipal solid waste warrant it to be considered with top priority for action.

URBAN MUNICIPAL WASTE

Generation of urban solid waste in Dhaka City is more than 4,000 tons/day, including about 200 tons of healthcare waste. Although, organic fractions dominate the urban solid waste, plastics and packaging waste are gradually increasing due to urbanization and uncontrolled urban sprawl.

Waste generation in Bangladesh varies seasonally. The country generates more waste in winter than in summer.

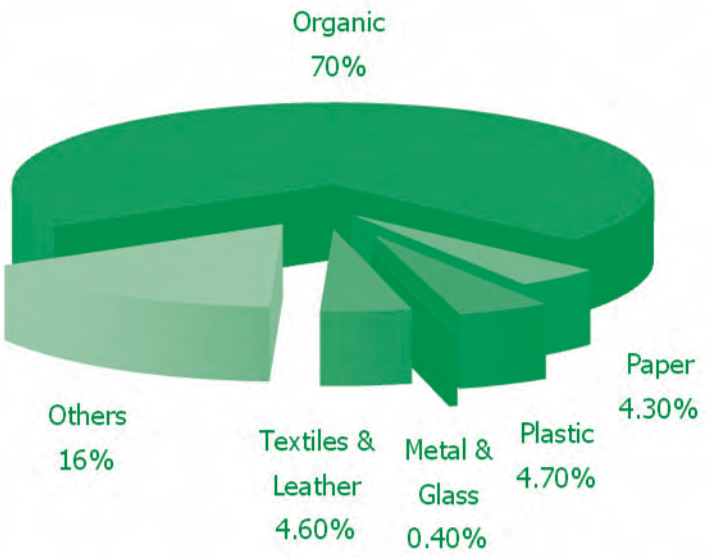
Although, a very small portion of waste is composted compared to open dumping, the current approach of decentralized composting has proved very successful in treating organic waste due to the initiatives and support from local NGOs such as Waste Concern, and other international agencies. Currently, many small-scale composting plants in Dhaka have shown more success in windrow composting.

However, composting in bigger scale is not very popular in the country. High operating and maintenance costs, incomplete separation, and lack of effective marketing impede the effective functioning of centralized composting plants.

Findings

In Dhaka City Corporation (DCC), the plastic waste has increased from 7% to 28% between 2002 and 2005. Over 170 tons of plastics are discarded daily, of which over 75% of soiled plastics are disposed in dumpsites or are not recycled directly. The entire operation of plastic recycling employs a chain of actors from scavengers to brokers. Economically, this sector generates over 22,000 jobs, saves foreign exchange of USD 52 million/year by avoiding import of virgin plastics and resins. One final push lacking from the government to uplift this sector is to consider the safety, health and environmental issues involved in recycling of plastic waste. An analysis of Bangladesh's solid waste situation clearly reveals the following:

- Bangladesh at present has a poor source separation practice and storage system.
- Poor collection efficiency of around 55% of the generated waste owing to the usage of conventional systems of collection, transportation and crude dumping of solid waste.



Urban Waste Compositions
Source: www.3rkh.net

- Waste generation differs significantly, especially in the urban centers, during the winter and summer seasons. For instance, in Dhaka waste generation during summer seasons is around 4,000 tons/day and 5,500 tons/day in winter seasons.
- Amidst various difficulties, due to the composition of the waste, with as high as 75% organic content, decentralized composting has been gaining huge momentum and success with support from international agencies and NGOs.

SOLID WASTE GENERATION IN URBAN AREAS OF BANGLADESH

City/Town	Waste Generation Rate (kg/cap/day)	Population in 2005	Total Waste Generation (ton/day)		Average Total Waste Generation (ton/day)
			Summer	Winter	
Dhaka	0.56	6,728,404	3,767	5,501	4,634
Chittagong	0.48	2,622,098	1,258	1,837	1,548
Rajshahi	0.30	468,378	140	205	172
Khulna	0.27	967,365	261	381	321
Barisal	0.25	437,009	109	159	134
Sylhet	0.30	386,896	116	169	142
Pourashavas	0.25	15,214,306	3,803	5,553	4,678
Other Urban Centers	0.15	9,217,612	1,382	2,018	1,700
Total	**-**	**36,042,067**	**10,839**	**15,826**	**13,332**

Source: www.3rkh.net

HEALTHCARE WASTE

Currently, Bangladesh has over 640 public and 280 private sector healthcare establishments. Roughly, 20% of total medical waste generated in Dhaka is categorized as infectious/ hazardous. The average generation is 0.55-1.10 kg/bed/day, with about 0.17 kg/bed/day of hazardous waste. World Bank estimates show that about 36,000 tons of healthcare waste is generated every year in Bangladesh. Hospital wastes are often mixed with urban solid waste. According to a study conducted by Bangladesh University of Engineering and Technology in 1999, the average rate of medical waste generations was 1.0 kg/bed/day. An estimated 200 tons of medical waste is generated in Dhaka every day. Most of which is dumped in municipal bins. Only few hospitals have on-site management systems such as burning, burial, autoclave and/or waste segregation. Some medical colleges and tertiary government hospitals have incinerators on site. Even though no alternative method is prescribed, the Department of Environment 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 bins before sending to the city corporation bins. Generally, solid wastes, saline bags, and non-sharp objects are disposed in improper ways. An overwhelming number of the waste pickers in Bangladesh sort these waste and sell all that can be recycled. The waste pickers adopt no protective clothing, exposing themselves to injury and sickness. Moreover, the municipal dust bins of Dhaka, where the hospitals place their waste are left exposed to the environment for days before collection. Another study reveals that apart from separating syringes/needles, most of the hospitals do not practice waste segregation before disposal.

Organic Waste Management in Bangladesh: Decentralized Composting

Bangladesh, with an average waste collection efficiency of 55% and the domination of organic content in the waste stream (>70%), have seriously crippled the local authorities in managing the solid waste. A research-based organization, Waste Concern, initiated a pilot project on community based resource recovery in Dhaka city in 1995. With further support from the government and international organizations, they further initiated community based decentralized composting projects in Dhaka. Activities under the project included door-to-door waste collection, composting of the collected waste in a decentralized manner (employing Barrel Type Composting, Aerator Type Composting and Box Type Composting) and marketing of compost and recyclable materials. Till date, these concepts have been replicated in 20 cities and towns in Bangladesh. Waste Concern has initiated a large-scale 700 tons/day composting plant in Dhaka city producing 50,000 tons of organic fertilizer every year. The organization looks forward with this project to reduce about one million tons of greenhouse gases over an eight year period under the Clean Development Mechanism.

Scavenging Medical waste
Image source: 3R South Asia Expert Workshop, Nepal 2006

Findings

The analysis of the current scenario of healthcare waste management in Bangladesh reveals the following:

- No specific agency has been identified as responsible for healthcare waste management in the country
- Lack of cooperation within and among various agencies is a pertinent problem
- In some areas, awareness initiatives have been undertaken by some NGOs. However, lack of awareness of potential risks exist
- Hospital authorities tend to overlook health issues as it involves huge budgets
- Lack of in-house management, such as the central recycling of selected items ike saline bags and containers inside some hospitals
- Unauthorized healthcare waste segregation, recycling and reuse is often conducted in and outside hospitals by informal sectors

There is no separate policy or handling rules for solid waste management, there is no specific legislation pertaining directly to the handling, transportation or disposal of healthcare waste in the Bangladesh Environmental. Protection Act (1995).

E-WASTE

Like other developing Asian countries, Bangladesh also imports tons of e-waste every year. The recent ban on importing e-waste to China has diverted much of it to Bangladesh and other neighboring countries due to cheap labor and recycling businesses. This e-waste recycling or computer recycling has been lucrative, with much money being made. It involves employing people to strip down the computers and extract parts that can be used again in machines to be sold on the high street. The rest is then burned or dumped, both of which are potentially hazardous to the environment. The process of extraction uses all kinds of chemicals, like acids which are dumped into the soil and go into the groundwater. Currently, there is not much data available on e-waste management in Bangladesh but it does not reflect the absence of any backyard smelting of circuit boards and manual dismantling of computer parts.

E-waste recyclers
Source: 3R South Asia Expert Workshop, Nepal 2006

Findings

Used Lead Acid Battery (ULAB) and plastic waste recycling has picked up its pace (mostly informal sectors) due to the change in the waste streams and increase in the vehicle use. These two areas of recycling employ thousands of informal sectors despite to their health risks and environmental pollution. For instance, every month, around 600 tons of lead is recycled, and the informal sector rebuilds over 100,000 pieces of plate separators besides repairing large numbers of other batteries. In 2005, over 85% of the produced batteries were recycled.

Three types of technology are currently in use:

1. Rotary Furnace (recovery rate of 65%)
2. Mondir Chulli (recovery rate of 60%)
3. Pan or Hole process (recovery rate of 55-60%)

The current recovery rate indicates the potential to upgrade the existing smelting technology to recover more lead from the ULAB compared to developed countries where the recovery rate is over 70% (Waste Concern, 2006).

GAPS FOR IMPLEMENTATION OF 3R

Worldwide, experiences indicate that applying 3R is a lucrative way of tackling waste management issues. The first step in this exercise is an assessment of the technology options available for implementing 3R-based solutions. Proactive policies and relevant legislations emphasizing 3R-based solutions are vital to achieve a higher success rate. While recycling is considered as technological ability, reduce and reuse is often considered

Recycling ULAB
Image source: Waste concern

management or policy oriented. In this context, the following sections present information on the technology and management aspects with the focus on 3R.

TECHNOLOGY GAPS

Waste Management has been the top priority issue for local administration bodies in the country. Continuously increasing quantities and inconsistent composition of the waste are some of the barriers to the effective implementation of management practices. However, it is widely believed that applying appropriate technologies can result in effective solutions to the crisis. In this context, the table below presents the status of technologies currently used in Bangladesh, with a special focus on 3R in urban municipal, healthcare and e-waste.

MANAGEMENT ASPECTS

Bangladesh is in need of a comprehensive solid waste management policy. In this attempt to address waste management issues, it is ideal to incorporate 3R policies as well. This helps to favor growth with a 3R mentality at an early stage. With limited land, natural and budget resources, the country can save money only by applying the 3R for the management of waste.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN BANGLADESH

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	⭘
	Fuel Recovery	⭘
	Material Recovery	⭘
	Sorting	○
	Pulverizing	⭘
	Composting	●
	Incineration	⊙
	Collection	⊙
E-Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Collection	⊙
Healthcare Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Incineration	⊙
	Collection	⊙

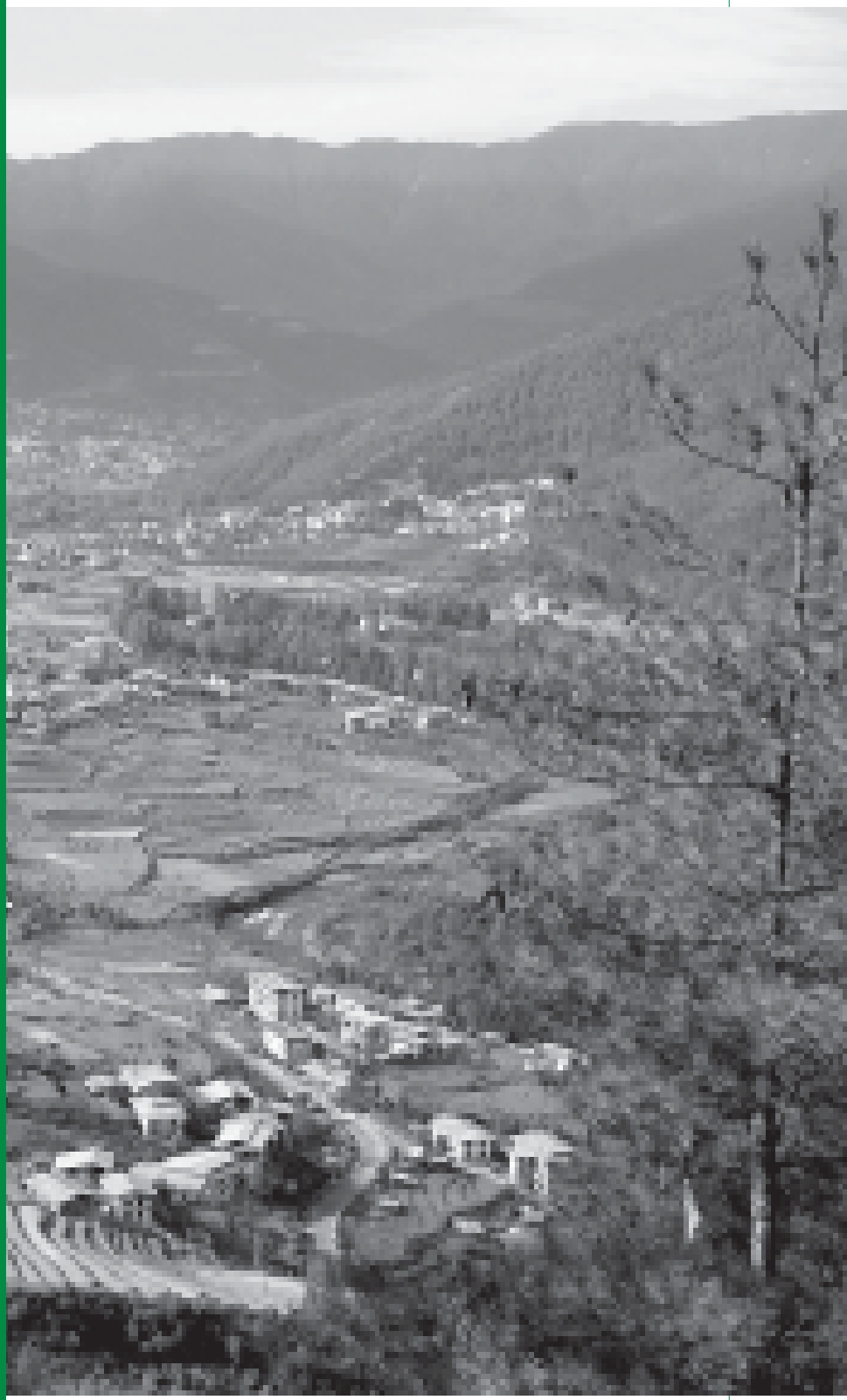
● Formal and Strong
⭘ Formal but weak
⊙ Informal but Weak
○ Informal and Strong
⊠ Technology Gap

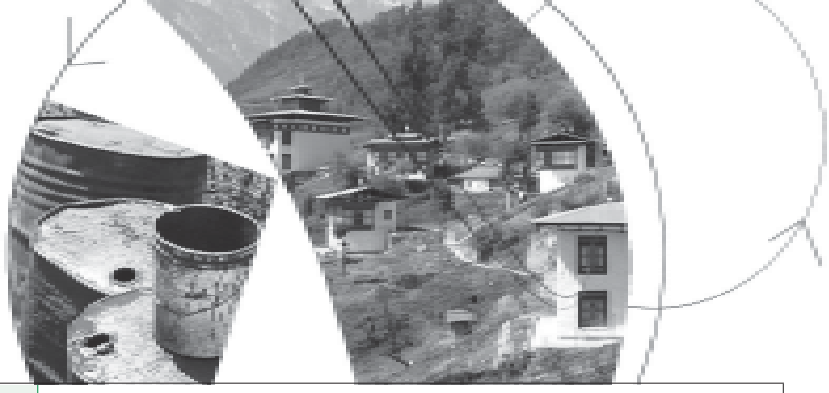
CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	National Environmental Policy 1992 National Environmental Management Action Plan (1995-2005)	○
	Direct Regulatory	• The Bangladesh Environment Conservation Act 1995 • The Environment Conservation Rules 1997 • The Environment Pollution Control Ordinance 1977 • City Corporation Ordinances and Pourshava Ordinance 1977 Draft "Solid Waste Management Handling Rules" • The Environment Court Act 2000 • Development of "Battery Waste Recycling Rules 2006"	○
	Economic	No specific economic instruments observed	☒
	Voluntary	Voluntary Initiatives by Government & Industry • Promotion of Cleaner Technology & Waste Minimization	○
	Information	Sustainable Environment Management Programme (SEMP) Dhaka Declaration 2004	○
	Procedural	Decisions on banning Polythene Shopping Bags	○
Support for 3R-related Activities		• Solid Waste Management Cell, Dhaka City Corporation • No specific support for 3R-related activities except few initiatives such as community-based waste recycling and resource recovery	○
Environmental Education		No specific programs emphasizing environmental education	☒
Scienc and Technology		• Implementation of a National Program for Recovery and Recycling of Refrigerants	○
Reduction of Barriers to International Flow		• Acceded the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal in 1993	○
International Cooperation		• Bangladesh Environmental Management Project funded by CIDA • Master Plan for the Solid Waste Management of Dhaka - Dhaka City Corporation with support from JICA • Community-based Composting Projects and Barrel Type Composting-UNICEF with 14 city corporations and Engineering • Solid Waste Management Plan for eight secondary towns of Bangladesh -Local Government Engineering Department (LGED) with support form ADB • Recycling Centers in 24 city corporations/municipalities as well as preparation of solid waste management plan–UNICEF • Urban Solid Waste Management Handling Rules of Bangladesh, and UNDP • Bio-medical Waste Handling Rules - Ministry of Environment and Forest and UNDP.	○
Cooperation of Stakeholders		Lack of cooperation among the stakeholders within the country	○
Promotion of Science and Technology for 3R		Under implementation level	☒

● Sufficient ○ Insufficient ☒ Gap

In Bhutan, the existing dumpsite has now reached its optimum capacity and the newly identified site still remains on the sketch board due to lack of funding and human resources. It has become a priority issue to develop a segregated waste inventory for the municipal waste...





3.2 Bhutan

BACKGROUND

Bhutan is a small landlocked nation located in eastern Himalayas, bordered by India in the east, south and west and by China in the north. With a total land area of about 38,000 km^2, the country is entirely mountainous rising from southern foothills of 160 m above sea level to over 7,500 m high peaks in the north. The country has a population of about 2.3 million.

Ever since Bhutan emerged out of a self-imposed isolation and initiated the Five Year Plan for its developmental activities, the national GDP growth rate increased from approximately 5% in 1998 to more than 8% in 2004. The per capita GDP is about USD 1,400. The revenue generation from hydropower electricity export and agriculture subsistence farming contributes significantly to the national GDP and commissioning of the 1,020 MW Tala Hydroelectric Power Station in 2006 is expected to substantially elevate Bhutan's GDP.

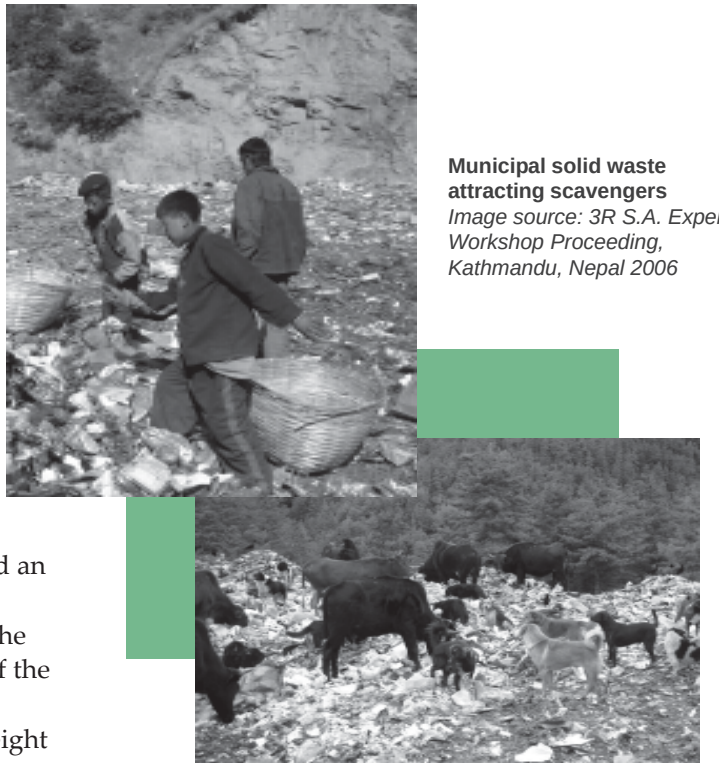
Unfortunately, this favorable socio-economic achievement is accompanied by negative pressures on natural resources and the environment. With population concentration in the urban areas and changes in consumption pattern driven by economic gains, various social services management challenges emerge. The unprecedented escalation of solid waste generation especially in urban areas has emerged as one of the most serious challenges, lately, to the Royal Government of Bhutan (RGoB). The RGoB, over the past years has been searching for options and opportunities to tackle the challenge. However, high demand of resources and management expertise coupled with mere technological capacity limits the chances to improve the deteriorating situation. The fragile mountain ecosystem adds to the limitation of finding and developing landfill sites. To date, public participation in the waste management system has not been strong. The waste quantity generated may not be alarming compared to the waste quantities in other countries, but for the population size and urbanization system in a steep mountain terrain, it has become a serious concern.

PRIORITY AREAS

In Bhutan, the existing dumpsite has now reached its optimum capacity and the newly identified landfill site still remains on the sketch board due to lack of funding and human resources. It has become a priority issue to develop a segregated waste inventory for the municipal waste. This is to enable analysis and adoption of the viable 3R and safe disposal options.

The first ever solid waste management facility, comprising a system of collection transportation and disposal (into an approximately 1.5 ha natural gully at Memelakha about seven kilometers away from the main town) is still operational since its inception in early 1993 for Thimphu municipality.

Before 1992, individual household disposal of the wastes into the nearby streams and open spaces prevailed. Small quantities and decomposting organic content/waste/material dominating solid waste may not have posed serious social threats those days to attract prior attention of the government. By April 2005, Phuentsokling (the second biggest town and the commercial hub of the kingdom) through DANIDA assistance developed a similar municipal solid waste disposal site at Toribari, about eight kilometers away from the town. The Phuentsokling waste disposal yard had an additional facility of a concrete pit for the disposal of the hazardous wastes (mainly the healthcare wastes). Also, as a component of the World Bank-assisted Urban Development Project (1999-2004), 10 municipal areas in eight districts developed urban municipal solid disposal sites. The rest of urban and rural areas still do not have specified waste disposal yards.



Municipal solid waste attracting scavengers
Image source: 3R S.A. Expert Workshop Proceeding, Kathmandu, Nepal 2006

URBAN MUNICIPAL WASTE

The rate of solid waste generation is also unknown in absence of reliable sources of information. The 1992 project document on solid waste management for Thimphu reported as 0.7 kg/capita/day after evaluating the carrying capacity and life span of Memelakha waste disposal site. Otherwise, there is insufficient information to indicate waste generation at the source point. Given the urban population figure of Thimphu as 79,185 for 2005 and the collected waste quantity as 36.7 tons for the same year, the per capita waste generation can be derived as 0.5 kg/person/day. However, this is not a reliable derivation for the reason that 36.7 tons does not represent 100% waste collection.

In the absence of a segregated waste data, it is difficult to confirm the composition of waste and suggest appropriate 3R techniques. The common perception being a developing country and from visual observations, the prevailing estimate is around 40% organic waste. The Policy Framework for Solid Waste Management, published by the Royal Society for Protection of Nature in 2006 focusing on public-private partnership for urban environment stated that Thimphu and Phuentsholing in 2005 collected 36.7 and 24.8 tons of solid wastes respectively per year. However, it does not specify any waste composition. Thus, it becomes difficult to verify waste management options.

Findings

As mandated by the Municipal Act of Bhutan, 1999, the waste collection and disposal responsibility solely depends on the municipal authorities. Thimphu City Corporation is solely responsible for MSW management of Thimphu city. It spends around BTN 2 million (approximately USD 55,000) annually for the collection and disposal of MSW. A formal waste segregation system is yet to be initiated. Municipal workers daily collect commingled wastes from all sources, wherever accessible. Various types of waste collection bins are provided by the municipal authorities in the streets and the road tri-junctions to facilitate waste collection from the individual sources. The waste picker trucks and the laborers of the municipal authorities then collect and transport the containers to the respective disposal sites. There is no information on waste generation of the various sources too.

Most of the higher value recyclable wastes such as metal pieces, cans and beer bottles, are traded informally by the scavengers and by the respective business entrepreneurs under the retail business licenses across the border to India and Bangladesh. Very few formal wastes dealers licensed as scrap dealers exist in Bhutan, like; two in Thimphu and one in Phuentsholing. The scavengers first collect recyclable wastes from the waste collection bins for either selling to the scrap dealers or informally trading across the border. The municipal waste collectors then separate the recyclable products in the process of collecting, transporting and disposing the wastes. They either sell it to the scrap dealers or trade informally across the border for their additional income. The formal scrap dealers too trade the collected scraps across the border. Two steel and iron industries set-up in Kamji and Pasakha in the south started to purchase some metal scraps from the formal as well as informal metal scrap dealers. Otherwise, very limited recycling plants exist in the country.

The only successful waste management venture was the wood sawdust management from the sawmills. There are few sawmills and woodcraft workshops within the Thimphu municipal area and until lately, sawdust was a concern to the authorities and the public alike. Now, with various sawdust recycling ventures (fuel-wood briquetting and compressed board production), the sawdust problem has subsided.

The government had initiated to setup a composting plant for managing the organic wastes of Thimphu at Serbithang under the DANIDA assistance. However, operation of the plant did not materialize for some logistical gaps between the involving agencies towards the completion of the project. An electricity supply substation construction and the access road pitching could not be completed to fully equip the plant for operation.

Cutting the PET bottles to pellets for sale across the border for recycling has been initiated recently in Paro and Thimphu. It is expected to reduce substantially quantity of PET bottles going to the waste disposal sites in the near future. The National Environment Commission initiated the plant in Paro and the Thimphu City Corporation in Thimphu. The agro industry in Serbithang which bottles mineral water has recently procured a machine for cutting PET bottles into pellets and has plans to procure more machines for distribution to their sale depot agencies throughout the country.

During the waste survey at the Memelakha disposal site, paper carton boxes, white paper and plastic wastes were observed. The bettle-nut cover, which cannot be easily composted constituted significantly in the organic wastes component. A private entrepreneur, Jungshi Paper Industry has initiated a paper recycling plant in Jemina, about 20 km from Thimphu town. It lacks manpower and transportation facilities to collect and transport raw materials to the plant. The government/private institutions also need to support the company by providing segregated paper wastes at source points. One prominent reuse of the papers as of now is wrapping small purchases from the retail shops.

Cardboard (carton) boxes are stacked in the scrap dealer yards for export across the border. One Scrap dealer in Thimphu, Karma Scrap mentioned that in the absence of inadequate space for construction of proper storage sheds, makes paper waste business including cardboard boxes is unattractive.

Overflowing dumpsite with urban waste
Image source: Mr. Nado Rinchen, Asia 3R Conference, Tokyo 2006

Its protection from moisture and rainwater, transportation cost and risk of fire hazards make paper scrap business unattractive. The Army Welfare Project (AWP) Samtse Unit recycles certain quantities of carton boxes. However, low return value, high storage liability and high transportation cost discourages AWP collection and recycling of the cardboard boxes.

Community participation
Image Source: Mr. Nado Rinchen, Asia 3R Conference, Tokyo 2006

Reusable plastics are used extensively as wrapping materials and carrying bags. However, most imported goods come wrapped in plastics and many wrappers are not reusable. After removal of the contents, plastics constitute significantly the collected waste and the littering seen around the city. Other than exporting recyclable plastics across the border, there are no plastic recycling mechanisms within the country. This leaves most of the plastics going to disposal sites or littering into open space. With proper research and some technical innovations there is a potential for recycling plastics wastes at the RSA Poly Products Private Limited in Phuentsholing. The company manufactures Poly film and Texturized Yarn from imported LDPE granules and POY granules respectively.

Lack of Materials Recovery Facilities and waste segregation systems exist. Lack of initiatives are also taken to promote the "junkshop" approach as of now. No private partnership has been encouraged in the waste management systems.

As such, in the absence of collective efforts, reduction of waste quantities going to the disposal sites and improving the city cleanliness has not been significantly successful. Solid wastes and stray dogs management has been attracting continuous tourist complains and media coverage in the kingdom lately.

HEALTHCARE WASTE

There are about five hospitals in Thimphu; Jigme Dorji Wangchuck National Referral (JDWNR) hospital, Basic Health Unit (BHU) at Dechencholing, Outreach Clinic (ORC) at Motithang, Indian Military hospital near the main town and the Dantak hospital at Babesa. Information access to the two Indian government hospitals is restricted. Even for national hospitals, the primary data collection is limited for some logistic formalities. The information on infectious wastes is presented in the following table.

Healthcare Waste Generation in Thimphu

Type of Facility	Infectious Waste (kg/day)	Sharp (kg/day)	Total (kg/day)
Government	28	2.50	31.00
Health Centers	1	0.10	0.75
Total	**29**	**2.60**	**31.75**

Findings

Initially, the JDWNR Hospital had an incineration plant to incinerate infectious healthcare wastes. Lately, the incineration plant has not been functioning and the Health Ministry did not attempt to renovate it. The Ministry's new policy does not encourage promoting incineration. Currently, 100% disinfection of waste is carried out and disposed into the municipal waste collection bins. A guideline is almost formalized for the medical waste management and a pharmaceutical waste management guideline is being developed. The healthcare waste management guideline mainly encourages encapsulation of the medical wastes for disposal at the dumpsites.

E-WASTE

No published information exists on estimation of quantity and disposition of e-wastes in the country. The informal reports state that the country imports substantial quantities of electronic and electrical devices, but everything goes back across the border for major repairs or as scrap when it gets obsolete.

Findings

Only very few minor repair shops exist in the country. Government agencies are the major users of computers, printers and telecommunication facilities. The Department of National Properties receive/collect all the discarded government properties including cars and electric/electronic items. It is then sold to private buyers through open auctions either as reusable items or as scrap material. The private parties then send it across the border for major repairs or as scrap materials. The electrical/electronic goods procured by the international agencies, private agencies and individual households go to secondhand buyers. When it gets obsolete or requires major repairs, it goes across the border, mainly to India.

GAPS FOR IMPLEMENTATION OF 3R

It is widely understood that applying 3Rs is an innovative achievement towards tackling waste challenges. The success of MSW management, however, is subjected to proper assessment of available technology and institutions that has proactive policies and relevant legislations emphasizing 3R-based solutions. Recycling is a technological ability, whereas reduce and reuse are management or policy oriented tools. In Bhutan, recycling issues were addressed as early as 1992 in the project document of the solid waste management for Thimphu City, but it lacked in implementation. This perhaps could be due to primitive technological options and insufficient awareness of the concept among national policymakers and during implementation Other than the National Strategy & Action Plan for the Integrated Solid Waste Management developed by the Ministry of Works and Human Settlement (MoWHS) with assistance from UNEP, no national policy papers address MSW management and, specifically, the 3Rs issue.

TECHNOLOGY GAPS

For a landlocked mountainous terrain country highly dependent on imported commodities, it is essential that appropriate technology be applied to tackle waste management problems; at the source as well as at the intermediate and the disposal management systems. The long distance and high gradient mountain terrain roads coupled with road maintenance conditions escalates transportation cost. The single location of the disposal site also increases the transportation distance from most of the suburbs. Scarcity of manpower especially skilled workers willing to work in waste management is another daunting challenge. Isolation of the disposal sites into the forest loses sight and attention of the influential policy makers on solid waste management issues. Location of disposal sitesin upstream water catchment areas the risk of pollution and contamination. The need of decentralized appropriate waste management centers, waste separation at source to ease waste management, establishment of transfer stations to reduce transportation cost and facilitate waste purification, location of waste management centers in visible areas to attract attention of all and downstream to reduce exposure to population are seen as crucial steps to address waste issues in Bhutan.

MANAGEMENT ASPECTS

Other than the Environmental Code of Practice (ECoP) developed by the NEC in 2000 and the Strategy & Action Plan for ISWM developed by MoWHS in 2006, no solid waste management specific policy exist. The policy documents mainly focuse on forest and bio-diversity conservation. A solid waste management policy or legislative tool addressing trading and in-country business system, people's participation and responsibilities towards achieving sustainable solid waste management is urgently required in the country. The following tables present an overview of the management, legislative and policy aspects of the country. Few specific steps required to improve the solid waste management situation in the country are highlighted below:

- Sorting out the differences amongst the involving agencies and making the composting plant at Serbithang functional,

- Institutionalizing compulsory waste segregation at source,
- Privatization of waste management systems levying SWM fees based on the "polluter pays principle",
- Institutionalization of bilateral arrangements for waste exports,
- Streamlining of trade licenses for specific businesses and supporting scrap dealers with spaces in the commercially viable areas.
- Researching and introducing more viable recycling options for various waste compositions,
- Developing and adopting the SWM legal tool.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN BHUTAN

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	☒
	Fuel Recovery	☒
	Material Recovery	☒
	Sorting	⊙
	Pulverizing	☒
	Composting	☒
	Incineration	☒
	Collection	⊙
E-Waste	Material Recovery	○
	Sorting	☒
	Pulverizing	☒
	Collection	⊙
Healthcare Waste	Material Recovery	☒
	Sorting	☒
	Pulverizing	☒
	Incineration	☒
	Collection	⊙

● Formal, Strong
◍ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	National Environment Protection Act (draft) National Solid Waste Management Act (to be drafted)	☒
	Direct Regulatory	• The Bhutan Municipal Act of 1999 • Environmental Assessment Act, 2000 • Regulations for the Environmental Clearance of Projects and Regulation on Strategic Environmental Assessment, 2002	○
	Economic	• Incentives to facilities and Industry Associations implementing Pollution Prevention programs • Funds from Financial Institutions	☒
	Voluntary	• Lack of Voluntary instruments	☒
	Information	• Environmental Code of Practice (ECoP) for Solid Waste Management, 2000 • ECoP for Sewage and Sanitation Management in Urban Areas, 2000 • ECoP for Hazardous Waste Management, 2002 • Policy Framework for Solid Waste Management, 2006 • National Strategy & Action Plan for Integrated Solid Waste Management, 2007	●
	Procedural	Formulation of standards and levels classifying wastes eligible for recycle. Implementation of ISO 14001 - Environmental Management System in government agencies & Business establishment	☒
Support for 3R- related Activities		• Central Government commitment • Local Government-Municipal Authorities • NGO-Royal Society for Protection of Nature	○
Environmental Education		Lack of environmental education (very informal and ad-hoc nature)	☒
Scienceand Technology		Lack of science and technological research and initiatives	☒
Reduction of Barriers to International Flow		• Response of the Royal Government to Basel convention	○
International Cooperation		• Environmental legislation and policy framing support from DANIDA	○
Cooperation of Stakeholders		No systematic cooperation between the government and the stakeholders and amongst various stakeholders in terms of solid waste management	☒
Promotion of Science and Technology for 3R		• Promotion of technology for waste minimization and recycling and recovery of waste in industries • Hazardous waste generation, treatment, storage and disposal	○

● Sufficient ○ Insufficient ☒ Gap

an Integrated Solid Waste Management System is being worked out to replace the current setup in the country. The Integrated Solid Waste Management Plan eventually replace the existing landfills and look into the sources of waste generation, collection, transfer, proper disposal, public awareness and strengthening of the institutional framework...

3.3 Brunei

BACKGROUND

Brunei Darussalam or Brunei is located in Southeast Asia on the northern coast of Borneo. The country occupies a total area of about 5,770 km^2. Brunei has about 380 km of land border and 160 km of coastline. The country is divided into two parts by the Malaysian territory of Limbang in Sarawak state. Brunei is close to vital sea-lanes through South China Sea linking Indian and Pacific Oceans.

Brunei has a population close to 374,000, the smallest in ASEAN and growing at a rate of 1.81% per annum. The country is administratively divided into four districts, Brunei-Muara, Kuala Belait, Temburong and Tutong. These districts are further divided into subdistricts. The largest city is the capital, Bandar Seri Begawan with a population of about 200,000. The economy is dominated by oil and natural gas and the wealth arising from the oil industry gives Brunei a high per capita Gross Domestic Product of USD 9,557 billion.

The Government of Brunei Darussalam is fully committed to sustainable environmental development. A National Environment Strategy was incorporated in both the Seventh and Eighth National Development Plans. Even though there is no Environmental Impact Assessment Regulation yet, Brunei Government requires EIA in the planning for large and heavy industries in the country. In accordance with these development plans, the country is gearing towards Integrated Solid Waste Management. Policies and Legislations on the improvement of the solid waste system have been adopted as administered by the Ministry of Development which allocated BRD 1 billion for the implementation of such projects in the Eighth National Development plan.

PRIORITY AREAS

Along with air pollution brought about by forest fires, solid and hazardous wastes brought about by urbanization and industrialization, have been identified as one of the main priorities in the Seventh and Eighth National Development Plans of the Government of Brunei. A study conducted by Department of Environment, Parks and Recreation (JASTRE) in 2005 indicates that solid waste generation in the country has reached up to 189,000 tons per year.

Presently, an Integrated Solid Waste Management System is being worked out to replace the current setup in the country. The Integrated Solid Waste Management Plan eventually replace the existing landfills and look into the sources of waste generation, collection, transfer, proper disposal, public awareness and strengthening of the institutional framework.

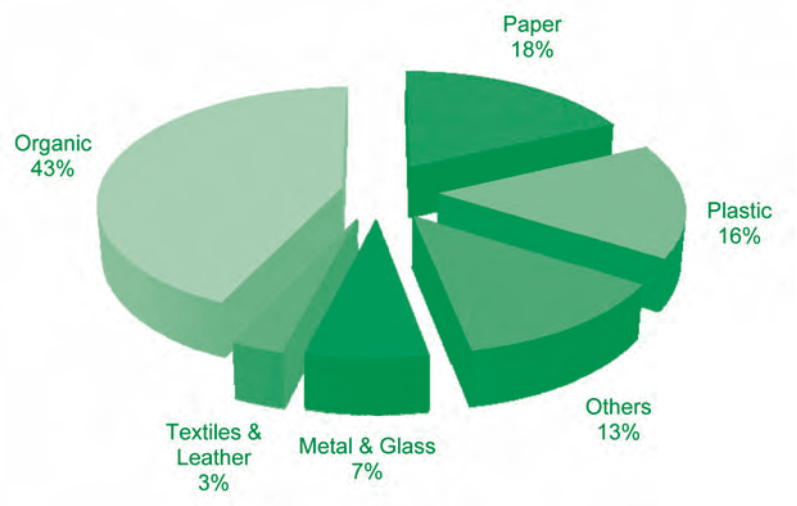
The agencies responsible for the implementation of the projects are the Department of Environment, Parks and Recreation and the Public Works Department under the Ministry of Development and the Ministry of Health.

Presently, there are no proper facilities for the disposal of most toxic wastes in Brunei Darussalam. Brunei Shell has its own procedure for management of toxic chemicals and hazardous wastes. However, a proposal has been made for the provision of a new and improved oil treatment/recycling centre. It would be able to offer benefits, not least catering for the numerous small workshops and garages that presently discharges significant quantities of waste oil into open drains and watercourses.

URBAN MUNICIPAL WASTE

Wastes in Brunei are classified under four major categories. These include residential, commercial, institutional, and industrial. Other wastes include waste soil, construction wastes, toxic wastes and hazardous waste, and waste / used oil.

A study conducted in 2005 indicates an average per capita waste disposal rate of about 1.4 kg/day. Out of the four districts, Brunei Muara has the highest generated waste of about 129,000 ton/yr. The figure below shows the waste composition in the Brunei Muara district.



Municipal Waste Composition in Brunei-Muara District
Source: Asia 3R Conference

With an increasing urban growth of about 72%, Brunei is expected to generate more solid waste. The facilities for the treatment and disposal of solid waste are limited. Thus, expansion in facilities to accommodate the expected increase, waste reduction, recycling and solid waste management needs to be considered.

There are several controlled dumpsites in the country located at least one in every district. In addition, one engineered landfill is managed privately by the BSP. At present, the landfill located in Brunei-Muara District is nearly reaching full capacity. The relevant agency has taken steps to reduce the volume of waste brought to this landfill including compactors on main roads and segregating metal waste. Plans for relocating the landfills and having incinerators have been formulated to address this issue alongside recycling.

Currently, solid waste collection in Brunei is carried out through:

- Private individual disposal to landfill sites and waste centers
- House to house collection (Brunei-Muara, Kampong Air)
- Registered private waste collecting companies (e.g. Brunei-Muara, Commercial areas, Light industrial areas)
- Waste bins centres (electrical waste compactor and skips in Brunei-Muara, skips and bins in Tutong, bins in Temburong, skips in Seria and Belait)
- Unregistered private collecting waste companies

Efforts have been made by the government for better management of solid waste in Brunei. This includes composting and the 'Recycling Drive' initiative in June 2007. As for the budgets are concerned, the 8th NDP, has an allocation of BRD 91.9 million for the implementation of environment related projects which equals only about 1.26% of the total development allocation.

Currently, no single agency in Brunei Darussalam has the sole responsibility for environmental matters, including enforcement of environment related laws. Such responsibilities are fragmented among different ministries, departments and units.

Even though there is no separate Ministry for environmental matters, two institutions play important roles in coordinating environmental policy, National Committee on the Environment (NCE) and the Environmental Unit of the Ministry of Development.

The NCE was established in 1993 by the Brunei Government as part of its Sixth National Development Plan. The NCE is a high-level inter-agency consultative body with representation from the relevant government departments and units concerned with environment. This is chaired by the Minister of Development.

The NCE is tasked with coordinating the environmental functions and sectoral interests of the relevant agencies within and outside the government. It ensures general coordination of environmental policymaking, providing an overall framework for environmental management, and oversees the implementation of national environmental activities, legislation and policies pertaining to the environment.

Sungai-Akar Brunei-Muara Landfill Site
Image source: Asia 3R Conference

The Environment Unit of the Ministry of Development serves as full-time Secretariat to the NCE. This Unit is also involved in policy development and guidance, and is responsible for regional and international environmental relations and for promoting environmental awareness in Brunei. In effect, the Environment Unit serves as the institution with direct operational competence over environmental matters.

In 1994, NCE established two working groups on specific environmental issues, with members from both the public and private sectors. The Solid Waste Management Working Group aims to establish a solid waste management strategy responding to all forms of wastes, including industrial, commercial and domestic wastes, sewage sludge, hazardous wastes and clinical wastes. The group is also tasked with formulating necessary legal framework and enforcement system to regulate the production of these wastes as well as to stimulate greater participation of the private sector in establishing waste management facilities.

Findings

Solid waste continues to be a persistent issue for most urban areas in the country. A growing population and an increase in development activities has been accompanied by an increase in the amount of domestic and industrial wastes generated. Consequently, some existing disposal sites have already surpassed their capacity. A new, engineered sanitary landfill for Brunei Muara District is still in the inception stage. The local administration considers development of an engineered sanitary landfill as the first step towards establishment of an integrated waste disposal arrangement.

With regard to present waste collection services, for settlements on land there is a house-to-house waste collection service provided by several private collectors. These services, presently being utilized only by a relatively small number of households, need to be further promoted. Alternatively, households are encouraged to dispose their wastes to roadside communal bins provided at strategic locations. Despite the availability of the above services and facilities as well as the ongoing efforts to promote cleanliness and awareness through campaigns, media promotions and talks, indiscriminate dumping and littering are still evident and burning of wastes remains a common practice by some households.

In addressing the problems associated with solid waste disposal in Kampung Ayer, house-to-house waste collection services and clearing of floating rubbish have since been introduced in many places. Public support in utilizing the available facilities and services is necessary to achieve the desired results. At the same time, efforts to extend waste disposal facilities and

services to other parts of Kampung Ayer also need to be pursued.

In dealing with solid waste special attention has been given to plastics. This is because of the hazards that plastic poses if they are not properly disposed. Littering of plastic bags and plastic packaging is a major nuisance. In an effort to reduce the use of plastic bags and plastic packaging, a campaign to raise awareness on the issue among consumers and retailers. As part of the campaign, Butra-Heidelberger Cement has switched to paper bags to pack their cement whilst seven other superstores and several textile and book shops have made pledges to reduce their use of plastic packaging by 20%.

Despite of many ongoing efforts, the problems associated with solid wastes need further attention. This amongst others includes:

- Promoting public awareness and support
- Strengthening regulatory and enforcement measures
- Improving the existing facilities and services
- Promoting the use of better performing technology

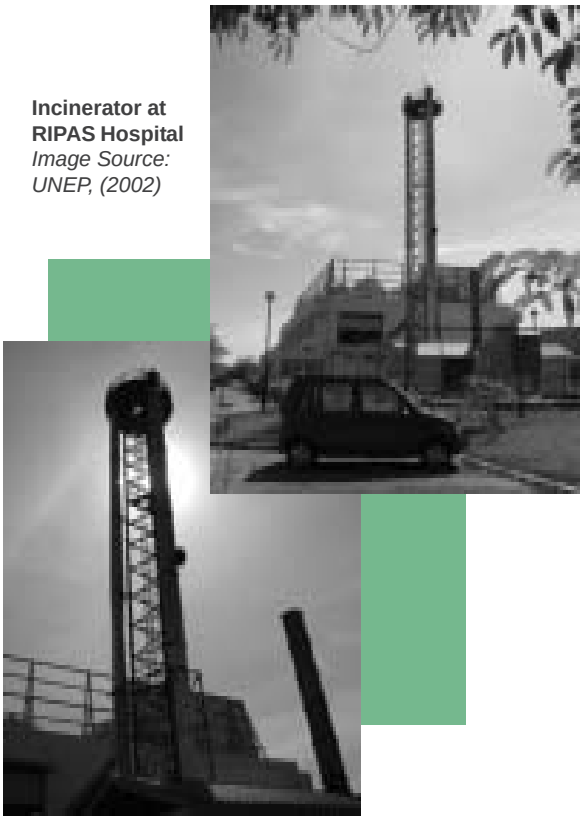
Continuous efforts are being made to improve coordination with the management of solid wastes through improvements in the system of refuse collection, increasing the coverage of refuse collection as well as to increase the number of public facilities. Currently solid waste collection services are provided only in the urban and urban fringe areas. Extensive communal bin systems have been initiated to supplement the existing house-to-house collection services; nevertheless, a common disposal practice is open dumping. The use of incinerators has been considered and expected to be introduced once feasible.

HEALTHCARE WASTE

In Brunei, medical and healthcare services are provided by government hospitals, health centers, and clinics all over the country. Flying Medical Services are provided to remote areas that are not accessible either by land or water. There are four government hospitals in each district and two private hospitals. The largest and the main referral hospital is Raja Isteri Pengiran Anak Saleha (RIPAS), equipped with modern and latest advances in medical technology.

A national workshop regarding dioxin and furan inventory was organized by UNEP in Brunei Darussalam in 2002. It was observed that incineration of hospital waste is widely practiced in the country. Incinerators in Brunei are relatively small and operated in batch mode. An inventory indicates a total of 1.4g TEQ for the year 2001, of which 42% is from the medical waste incinerators and 41% from land filling and dumping, followed by uncontrolled burning (5.7%) and transport (4.8%). The workshop has revealed that the major dioxin and furan sources in the country are hospital waste incineration and residues from sewage sludge treatment plants.

Certain policies on environmental health are stipulated in various administrative orders or circulars and not in regular legislation. There is a National Health Care Plan (2000-2010) which contains key strategic areas for health promotion, disease promotion and disease prevention. Currently, there is no Public Health Act in Brunei stipulating environmental health functions. The Department of Health Services will undertake work regarding this matter. Further, there is no national policy specifically



Incinerator at RIPAS Hospital
Image Source: UNEP, (2002)

for health settings but the principles of health cities have been in place in the country for many years. Relevant legislations to environmental health in Brunei include: Petroleum Mining Act (1992), Forest Act, Water Supply Act, Poison Act, Town and Country Planning, Ports Act, Land Code, Agriculture, Pest and Noxious Plant Act and Infectious Disease Order (2003).

Findings

The following are three healthcare waste incinerators in Brunei Darussalam

- RIPAS Hospital in Bandar Seri Begawan
- Suri Seri Begawan Hospital in Kuala Belait
- Penaga Hospital in Seria

Healthcare waste incinerator used in Brunei is composed of a primary chamber operating between 810^{0}C – 9230^{0}C, an after burner or a secondary chamber at a temperature of 980^{0}C – 1090^{0}C. The operating temperatures ensure complete combustion of wastes.

Based on the environmental health profile conducted by WHO (2004), the generated dioxin estimation in 2001 in Brunei Darussalam is about 195,040 kg coming from the healthcare wastes from the three districts (except Temburong). A double chamber incinerator (1,000^{0}C) is available at RIPAS Hospital, which receives hospital waste for combustion twice weekly. The amount of chemical and hazardous wastes for disposal is unknown but the Brunei Shell has a sanitary landfill which accepts both solid waste and asbestos.

Although the country is a party to Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, currently, there is no Public Health Act in Brunei Darussalam. The National Health Care Plan 2000-2010 has specifically identified issues related to environmental health under the strategic themes of "Enhancing Healthcare Services". Areas for improvement required in Brunei include policies and legislation for environment and health.

E-WASTE

E-waste in Brunei, as in any country, is composed of computers, mobile phones, radios, cameras, refrigerators, washing machines, and batteries. Out of 357,800 Bruneians, 191,900 had access to mobile phones in 2006.

A survey conducted by the Department of Recreation, Parks and Recreation (JASTRE) of the Ministry of Development, at the Sungai-Akar Landfill in 2005 showed that e-waste contributes to only 1 %. Though in smaller quantities, the toxicity of the e-waste matters more than the quantity.

Findings

According to JASTRE, Brunei has no specific e-waste legislation yet, but the department has drafted an "Environmental Law", which is still in the pipeline. However, JASTRE advises Bruneians not to throw their e-waste at the Sg Akar Landfill, but instead send them to recycling companies such as Daikyo Environmental Recycling Sdn Bhd in Serasa, or to scrap metal yards such as AMCOM Jaya in Kg Bebatik Kilanas, or return the goods back to the company, which would then sell them to either of these places.

In Brunei, the private sectors undertake collection of batteries and later exports them to other ASEAN countries.

In 2005, a study titled "A Multi-disciplinary Approach for a Sustainable Environment", a project on e-waste, was conducted by SHBIE University in Brunei to take action and create awareness about the importance of proper e-waste management among the public. In this study, the importance of recycling was encouraged among students.

Media campaigns through newspapers were used to encourage the proper management of e-waste and the promotion of 3R practices (reuses, reduce, recycle) in Brunei.

The toxicity and inherent problems of e-waste are well known. The amount of e-waste produced in Brunei is on par with other developing Asian countries. The national government is also aware of the problems and has been taking all efforts to address the issue. However, no initiative appears to have been taken in inventorying and documenting the compounding problems arising from e-waste.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN BRUNEI DARUSSALAM

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	☒
	Fuel Recovery	☒
	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Composting	O
	Incineration	O
	Collection	O
E-Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Collection	☒
Healthcare Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Incineration	●
	Collection	☒

● Formal and Strong
O Formal but weak
⊙ Informal but Weak
○ Informal and Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	National Environment Strategy, 2005	☒
	Direct Regulatory	Recommended Procedures for Disposal of Waste Batteries	☒
	Economic	Lack of specific Information Instruments	☒
	Voluntary	Measures to reduce use of Plastics Lack of Voluntary Initiatives by Government, Industry and communities	○
	Information	Lack of specific Information Instruments	☒
	Procedural	Lack of specific environmental quality surveillance instruments	☒
Support for 3R-related Activities		Private Sector Initiatives such as Oil and Gas Discovery Centre (OGDC) in Seria	☒
Environmental Education		No emphasis on environmental education	☒
Science and Technology		Promotion of clean technology · Waste minimization in small scale and large scale industries	○
Reduction of Barriers to International Flow		Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal (1989) 5 May 1992.	○
International Cooperation		Inadequate Information sharing, Training, Public Awareness and technological initiatives	○
Cooperation of Stakeholders		Lack of cooperation among the stakeholders within the country	☒
Promotion of Science and Technology for 3R		Under implementation level	☒

● Sufficient ○ Insufficient ☒ Gap

One of the emerging concerns of Cambodia's solid waste sector has been the recent rapid transition from biodegradable materials such as paper bags and banana leaves to non-biodegradable materials, principally plastics. Plastic waste can be seen close to nearly every town and village in the country and are beginning even in remote areas.

Waste scavengers sorting urban refuse
Image source: Phil Byer, Waste Econ

3.4 Cambodia

BACKGROUND

Cambodia currently has a population of over 13 million, of which about 15% presently live in urban settlements. Existing information on solid waste generation indicates that nearly 700 tons of waste is generated daily in the main cities and provisional towns across the country (WNA, 2001).

Outside Phnom Penh, the capital of the country, and a few provincial towns, most of the waste is simply dumped on vacant land outside of the towns. Most of the dumpsites are usually uncontrolled in nature, poorly managed and pose significant risks to both the environment and the public.

Waste collection in Phnom Penh
Image source: Murray Haight, Waste Econ

One of the emerging concerns of Cambodia's solid waste sector has been the recent rapid transition from biodegradable materials such as paper bags and banana leaves to non-biodegradable materials, principally plastics. Plastic waste can be seen close to nearly every town and village in the country and are beginning even in remote areas. All forms of plastic currently in use have become persistent sources of environmental pollution. Other waste sectors, medical, industrial, hazardous/ toxic, are now beginning to increase in volumes due to the recent rise in industrial development.

PRIORITY AREAS

Available information indicates that recycling and reuse of materials and waste have been happening as large informal operations. An analysis of the waste generation and management issues in the country clearly indicates two major areas for priority action:

- Recycling and reuse of hazardous waste materials dumped from neighboring developed countries
- Unscientific recycling of Used Lead Acid Batteries

Issues related to waste management are diverse and differ based on various aspects from generation patterns to treatment and disposal technologies, to intensity of problems created. However, this study focuses primarily on urban municipal wastes, healthcare and e-waste. Essentially, this gap analysis attempts to investigate and present the current state of generation, characteristics, technologies, policies and legislations for the focal sectors, urban municipal wastes, healthcare and e-waste.

Handling LAB without proper safety measures

Image source: SBC (ULAB Project Cambodia)

URBAN MUNICIPAL WASTE

From 1979 to 1993 the Department of Public Works and Transport (DPWT) was responsible for solid waste collection after which this sector has been privatized. The following agencies have carried out the solid waste management in the City.

- June 1994 to July 1995
  - Pacific Asian Development, France
- Aug 1995 to Dec 1995
  - Local Administration
- Jan 1996 to Nov 1996
  -Public Cleansing Company, Cambodia
- Dec 1996 to Jul 1997
  - Environment Development Company, Germany
- July 1997 to date
  - PSBK, Cambodia (a private sector waste management agency)

Although at present a private company is responsible for collection and transport of solid waste in the entire city, the waste management system in Phnom Penh is still reported to be poor. It is estimated that 70% of the waste in urban districts is collected and maximum of 80% of the households are connected to the service (ACHR, 2002).

Though four urban districts are covered, most of the poor urban communities do not receive such service. PSBK is responsible for collecting waste from the City as a whole, transporting and disposing them in the disposal sites identified by the Municipality of Phnom Penh (MPP).

The Cleaning Authority of Phnom Penh, now called The Phnom Penh Waste Management (PPWM) under DPWT, is supported by the Norwegian Agency for Development Cooperation (NORAD). A similar project supported by NORAD and ADB under the Water Supply and Drainage Project is the Neighborhood Improvement Program (NIP) implemented by DPWT with technical assistance from Inter-Consult International. The main activities of NIP are to provide capacity building to PPWM and implement a pilot project on community based SWM.

Community Sanitation and Recycling Organization (CSARO) is a local NGO that facilitates organizing community-based primary waste collection while PPWM is responsible for secondary collection, transporting and disposing them into the existing disposal sites. PPWM is also responsible for improving the conditions of the existing disposal sites and PSBK has to pay USD 6,000 per month to PPWM for this improvement. It is reported that waste is separated prior to secondary collection and brought to the community composting center.

Apart from privatization and NIP, limited activities related to SWM and hygiene were taken by CSARO with objectives to improve living condition of the poor in Phnom Penh, and to improve betterment (physical, social, economic) for waste pickers. The activities implemented by CSARO are community-based and target waste pickers only.

Another ongoing pilot project is on composting, funded by Municipality of Neufert, Germany. MPP allocated 2,000 m^2 of land at the existing landfill for composting. Since its inception in 2000, the project has produced about 20 tons of compost per year.

Findings

On-going difficulties in solid waste management can be attributed to shortage in skilled and experienced human resources to manage and operate waste management systems; appropriate equipment to ensure cost effective collection and transportation of waste; accessible finances due to inefficient revenue generation; and remuneration of workers to encourage effective operation.

In the past, recyclable materials were kept and either used, sold or exchanged. However as progress is made and consumption grows, disposal practices are changing with growing volumes of waste being dumped everywhere. Unfortunately, this has been paralleled with a contraction in the recyclable materials markets. Materials, which were previously exported to neighboring countries where the systems are present to undertake commercial recycling have either disappeared or shrunk in most cases, except for the very high value materials (aluminum and other selected metals). Additionally, export duties have been introduced which makes the recycling markets uneconomical. This has led to an increase in the volumes of waste being dumped.

HEALTHCARE WASTE

The Ministry of Health is responsible for healthcare throughout the country. Hospitals, by and large, have facilities with more than 50 beds and are publicly owned. On the other hand, health centers generally have less than 50 beds and are often publicly owned. Clinics and polyclinics are usually under the private sector and only offer outpatient services. Most hospitals and health centers were constructed during the 1950s and 1960s, while a number of polyclinics and clinics are presently built to meet the dramatically increasing population, particularly in Phnom Penh.

Limited information is available regarding the management of healthcare waste in Cambodia. The World Health Organization has conducted a survey in 44 healthcare facilities; 10 hospitals, 14 polyclinics, 12 clinics, and 8 health centers (WHO, 2003). The results of the survey indicate that hospitals, polyclinics, clinics, and health centers generate about 825 kg of solid waste per day. Of these, about 403 kg is considered medical waste, and the rest is considered general waste.

The survey also reveals that most hospitals, polyclinics, clinics, and health centers do not have their own systems for waste segregation. Different types of wastes, including infectious, sharp, and pathological waste, are placed in the same bin or container, which is not colored and labeled. However, waste segregation is carried out by some hospitals and polyclinics. Syringes are stored separately from other waste at the point of generation. For instance, some facilities put the syringes into bottles of pure water, while others put them into safety boxes.

A secondary collection system normally is carried out by the PSBK Company, which was given this responsibility by the Municipality of Phnom Penh. The company uses compactors for the collection and transportation of waste from hospitals, polyclinics, clinics, and health centers. The frequency of collection is once a day, except national holidays and weekends. Ironically, the categories of solid waste to be collected by the company have not been clearly defined in the contract. In other words, the company is entitled and responsible to collect all categories of solid waste within the city.

Cambodia presently does not have a special treatment facility or central incineration plant for treatment of medical waste. A large amount of general and medical waste produced by hospitals, polyclinics, clinics, and health centers is collected by the PSBK Company and disposed at an open dumping site known as Stung Mean Chey. The site has been used since 1960 and has an area of about 8 ha. It is not equipped with appropriate technologies for solid waste management. The leachate from this site is discharged directly into the public sewer.

A few hospitals are equipped with conventional incinerators for burning healthcare waste. It has been reported that the operating temperature in those units ranges from 350^0C to 600^0C. It has also been determined that the healthcare wastes cannot be completely destroyed at these temperatures.

Healthcare facilities without incinerators send their wastes to hospitals, with on-site incinerators for burning. However, it has been indicated that on-site incinerators treat a relatively small amount of waste. The survey reports that approximately 350 kg of medical waste is burned each day by incinerators. The ash or residues resulting from the incineration process are partially disposed at dumpsites located in the vicinity of the incinerators; the rest is collected by the PSBK Company and is disposed at the open dumpsite.

Findings

The medical waste generated by hospitals, polyclinics, clinics, and health centers in Phnom Penh City are not adequately managed. Most facilities have not been equipped properly for the treatment of the medical waste. The amount of medical waste burned by on-site incinerators within public hospitals is much less than that disposed at the open dumpsite. Primary collection and transportation is carried out by untrained workers of each facility, while secondary collection is carried out by the PSBK Company.

It has been demonstrated that relevant issues giving rise to the improper management of medical waste are:

- Jurisdictions for medical waste management have not been developed, or are rarely well-established and clear
- A well-structured organization for the management of the medical waste has not been set up
- The technology required to manage the medical waste is not available due to the limitation of financial support
- Human resources in the field of solid waste management are insufficient

E-WASTE

Like in any other developing country e-waste management is a major issue in Cambodia too. However, the economic status of the country attracts more of importing / dumping issues rather than locally originated e-wastes. Cambodia is starved of electricity supplies and hence people in rural areas thrive on storage batteries as means for an electricity source. In this context, Lead Acid Batteries play an important role in powering the economy.

Various measures have been taken at the local and national level for the appropriate treatment of the used lead acid batteries.

As the name implies, these batteries consists of hazardous materials that often result as wastes demanding environmentally safe recycling and disposal. Used Lead Acid Batteries (ULAB) are common in Cambodia and are either imported from neighboring countries as whole units or are assembled within the country.

ULAB recycling enterprises are common in Battambang Province and are usually built on a plot of land. The ULAB breaking operation is manual. The lead bearing waste is placed on the ground near the smelting furnace. The battery cases are sent to the milling machine and the remainders, such as the plate separators, are put into a pile for incineration. The lead bearing waste is melted in the open and without any form of ventilation or extraction using a small crude melting furnace made from a length of metal tube about 1 m and 0.4 m in diameter. Charcoal is added to the leaded scrap as it is charged to the melting furnace in order to encourage reduction of some of the battery paste (lead oxide) to produce metallic lead (lead bullion).

Findings

Recently, the melting operation was temporarily shutdown due to complaints from people living and working close to the operation. Following this, the melting furnace was relocated to a small empty elevated plot of land surrounded by vast rice fields. The lead output and the operating procedures are the same, but the battery breaking process is still carried out at the first smelting site.

In order for the laws and other related regulations to be effective and followed by people throughout the country the following action must take place:

- The Basel Convention Guidelines on ULAB should be translated and disseminated
- MoE should promote Environmental Laws and Regulations.
- MoE should disseminate the Laws and Regulations in cooperation with other concerned ministries.
- The MoE should establish guidelines on ULAB and explain the adverse effects on human health and environment if they are not managed properly.

GAPS FOR IMPLEMENTATION OF 3R

Worldwide experiences indicate that applying 3Rs is a lucrative way of tackling waste management issues. The first step in this exercise is an assessment of the technology options available for implementing 3R-based solutions. Proactive policies and relevant legislations emphasizing 3R-based solutions are vital to achieve a higher success rate and form the next step. While recycling is considered as technological ability, reduce and reuse is often considered management or policy oriented. In this context, the following sections present information on the technology and management aspects with focus on recycling and reduce/reuse, respectively.

TECHNOLOGY GAPS

Being a relatively underdeveloped country in South East Asia and impounded by various issues until the recent decades, survival has been the priority. Environmental protection and waste management issues have not received adequate attention in both the government and the community.

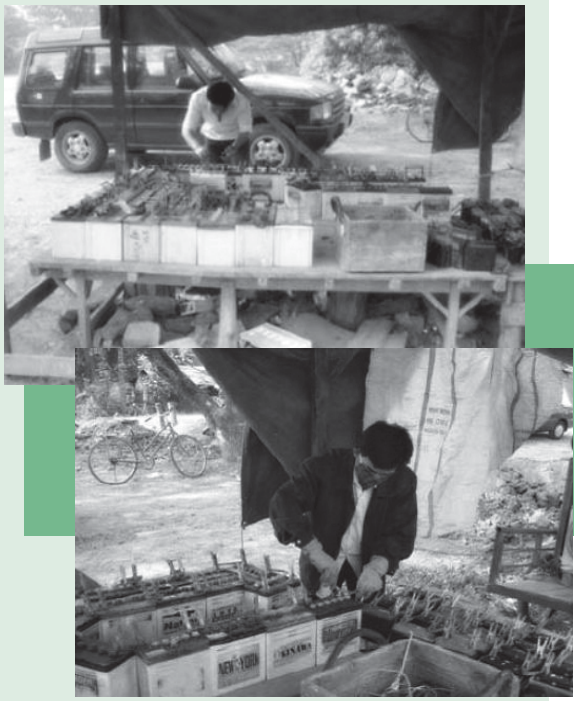
MANAGEMENT GAPS

Cambodia has been confronting various social issues such as ensuring livelihood and basic sanitation facilities amongst other threats of food and energy security. In recent years, however, the country has been attempting to stabilize itself economically. Multilateral agencies, development banks and funding organizations have been helping the country in attaining decent living conditions. In this endeavor, some of the initiatives have also focused on improving the management, legislative and policy position of the country. In this context, the following Tables presents the management aspects, policy and legislative measures in the country.

Lead Acid Batteries of Cambodia

The number of people using Lead Acid Batteries and Used Lead Acid Batteries have increased significantly over the years in Cambodia due to economic expansion in the urban areas and electricity demand in suburb and rural areas, where these batteries serve as the alternative power after electricity. A separate survey conducted by the New Zealand based Meritec Group in August 2001, concluded that in the rural areas about 55% of households use Lead Acid Batteries of a car, truck or motorcycle for domestic purposes.

A typical battery recharging shop in Cambodia services batteries and collects ULAB for resale to the waste recyclers and for recharging. They recharge around twenty to thirty batteries per day using a diesel generator in a makeshift house. It is evident from the surrounding soil color near the shop that the spent acid and other effluents are directly discharged without proper storage and handling procedures. Most of the ULAB recyclers are aware of the safety handling protocols but unaware or ignorant towards the environmental damages and long-term health issues. Unlike earlier days, the number of customers and the flow of ULAB are decreasing for the local recyclers. Local scavengers visit houses for battery collection and recycling. An unofficial report mentions the Transboundary Movement of these batteries to Vietnam and Thailand for recycling.



Handling LAB without proper safety measures
Image source: SBC (ULAB Project Cambodia)

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN CAMBODIA

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	☒
	Fuel Recovery	☒
	Material Recovery	○
	Sorting	○
	Pulverizing	○
	Composting	☒
	Incineration	☒
	Collection	⊙
E-Waste	Material Recovery	○
	Sorting	○
	Collection	○
	Pulverizing	○
Healthcare Waste	Material Recovery	☒
	Sorting	⊙
	Pulverizing	⊙
	Incineration	⊙
	Collection	⊙

● Formal, Strong
◍ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	National Environmental Action Plan 1997	○
	Direct Regulatory	Law on Environmental Protection and Natural Resources Management, 1997	○
	Economic	ADB	○
	Voluntary	Lack of voluntary instruments	
	Information	Limited public awareness	☒
	Procedural	Lack of specific environmental quality surveillance instruments	☒
Support for 3R-related Activities		• World Bank, International Monetary Fund, • Mekong River Commission, • United Nations Development Programme, • Food and Agriculture Organization of the United Nations, • NGOs and ADB.	●
Environmental Education		Less emphasis on environmental education	☒
Science and Technology		• National inventory of e-waste projects under the Basel Convention	○
Reduction of Barriers to International Flow		• Party to the Basel Convention, 2001 • National inventory of e- waste Projects in progress under the Basel Convention	○
International Cooperation		For Environmental framework -the technical and financial aspects Partnership with • World Bank, International Monetary Fund, • Mekong River Commission, • United Nations Development Programme, • Food and Agriculture Organization of the United Nations, • NGOs, and ADB. Still requires assistance the international donors both financial and technical support on 3R	○
Cooperation of Stakeholders		Community Sanitation and Recycling Organization, Cambodia	●
Promotion of Scienceand Technology for 3R		• Under implementation level	☒

● Sufficient ○ Insufficient ☒ Gap

An analysis of generation rate, current management practices, and available technologies for waste handling and disposal in China identifies Industrial Solid Waste (ISW) as a priority area. Since 1995, ISW has been the main source of solid waste in China. With the current economic development, the quantity of ISW is increasing rapidly in the country...

3.5 China

BACKGROUND

Referred as 'workshop of the world', China's rapid growing 'economy-might' has surprised many economist and industrialized countries with its ever-expanding production lines. The GNP per capita has increased from USD 620 to 1,000; urban population from 30 to 35%; and urban municipal solid waste generation from 0.79 to 1.15 kg/capita/day during 1997-2003. In the last two decades, the economy of China has been growing at an annual rate of almost 10%. The total amount of waste has been growing at a similar pace of 8-10% annually. Currently, every Chinese produces about 440 kg of solid waste every year. At this rate with the total population of China at approximately 1.25 billion, the total amount of waste is around 500 million tons.

China's waste management revealed that the failures in slowing down waste growth, employing the best available solid waste technology, systematizing source separation of household waste and household hazardous waste and setting the right incentives for waste collection and environmental hygiene services are the major pitfalls in solid waste management. In addition, the increasing recyclable contents in the waste stream especially in the more affluent areas, and inadequate monitoring of the waste compositions, pollution abatement methods in treatment and disposal appear to be the drawbacks of solid waste management in the country.

PRIORITY AREAS

An analysis of generation rate, current management practices, and available technologies for waste handling and disposal in China identifies Industrial Solid Waste (ISW) as a priority area. Since 1995, ISW has been the main source of solid waste in China. With the current

economic development, the quantity of ISW is increasing rapidly in the country. Compared to MSW collected and transported in 2002, ISW generated was approximately seven times higher (about 945 million tons). Mining gangue is the largest component of ISW (making up 27.5%) of the total waste.

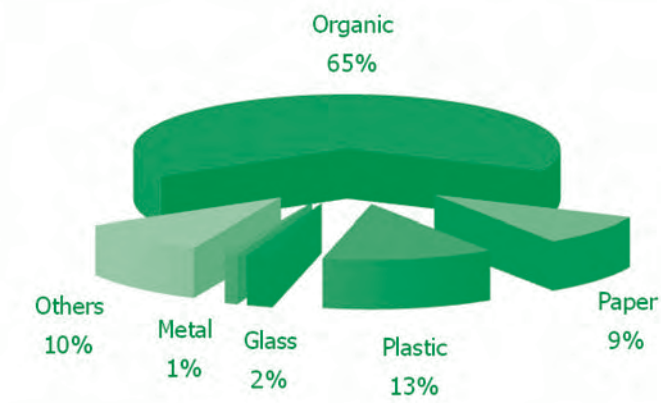
Within the Chinese industrial sector, the coal mining and processing industry contributes most to the total quantity of ISW. Implementing concrete 3R measures to the industrial sector can yield immediate results.

URBAN MUNICIPAL WASTE

According to the available data and literature, total MSW generated annually in China varies between 120-136 million tons. The rapid expansion of cities and urban sprawl has led to higher consumption and increase in the amount of urban waste generated since the living standard of the urban areas is higher than in the countryside. With the increase of GNP per capita since 1997, the same has been reflected in the amount of urban municipal waste generated.

Urban Municipal Solid Waste Generation

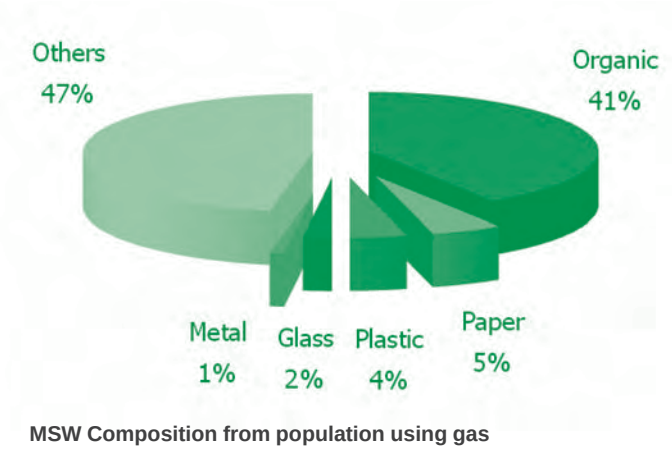
Year	2003	1997
GNP per capita (US$)	1000	620
Urban population (% of total)	35	30.3
Urban MSW generation (kg/capita/day)	1.15	0.79



MSW Composition from population using coal
Source: www.3rkh.net

Of the total solid waste, nearly 60% is generated from 52 cities having a population of over 0.5 million. China had recently surpassed the US as the world's largest municipal solid waste generator, nevertheless with little demonstrated and concrete waste reduction efforts. With respect to the amount of MSW generation and its composition, the waste treatment and disposal methods are weak. For instance, most of the generated waste (above 70%) are landfilled (most of it is simple dumpsite) and 20% has been composted in the past decades.

Informal recycling activities take place at every stage and remarkably influence the waste stream. Much more waste is generated than which actually arrives at the disposal site. This informal recycling takes place at different stages from the household, where the waste is generated till reaching the dumpsites. The share of recyclable waste exiting the waste stream can be as high as 60%.



MSW Composition from population using gas
Source: www.3rkh.net

Findings

China's recycling rates are lower than most other countries and likely to be much lower than intuitively believed. The secondary materials market in China is affected by several factors including: value to the recycler, avoided disposal costs and price paid in the exporting country, avoided disposal costs and price paid to domestic producers, cost of domestic and international transportation and cost of enacting environmental safeguards associated with recycling the material. Much of the Chinese recycling systems are being adversely affected by the import of low-cost secondary materials from high-income countries that are exporting these materials to avoid using their limited landfill capacity and paying their higher costs of disposal largely due to more stringent environmental regulatory requirements. In 2002, the US exported an estimated USD 1.2 billion in scrap and secondary materials to China – up from USD 194 million five years earlier (World Bank, 2005).

Even though, there is no technological standard for the recycling of plastic wastes in China, the law and regulation for recycling plastic waste has been enacted and an efficient collecting system has been formed with the economic development of China. The recycling of plastic wastes is becoming a new attractive field in that it can save resources and protect the environment. From the view of environmental protection as well as the economics, a novel and reasonable technology is needed. This is the responsibility of the governments and the producers. The reuse of waste plastics,as one of the avenues to tackle the resource shortness, is expected to play a vital role in the near future. Since China produces 29% of the world's MSW every

year, an integrated solid waste management system that includes the reduction, reuse recycling and disposal of waste material plays an important role in China's sustainable development.

In some rural and peri-urban areas, the local recyclers have the luxury of selecting recyclable items from the refuse. They mainly go for beverage bottles and cans, leaving behind the rest. The local authorities and municipalities pay little attention to the heap of refuse collected at the backyard even after series of complaints launched by the residents. Besides degrading the aesthetic values, they also attract unwanted scavengers and pose a serious threat to health and hygiene.

Empty beer bottles packed for local recyclers
Image source: Mr. Ou Jia

Green Growth in China

China has already taken significant steps to improve its ecological efficiency of rapid economic growth by pursuing the bold and ambitious Resource Saving Society Initiative. Developed and promoted by the Department of Environment and Resource Conservation of the National Development and Reform Commission, The Resource Saving Society Initiative is currently implemented by the Government of China through the National 11th Five-Year Plan (2006-2010). It is hoped that other countries in the region will soon follow suit. At the 2nd Green Growth Policy Dialogue, organized in May 2006, Ms. Zhao Jiarong, Director-General, Department of Environment and Resource Conservation, National Development and Reform Commission of China announced six major national measures in pursuit of green growth and a resources saving society:

- Establish sound legislation, regulation and standardization framework
- Speed up optimization of the industrial structure, including improvements of energy consumption and use of high quality and alternative energy
- Promote improvement of technological processes and scientific research for energy efficiency and recycling technologies
- Improve energy consumption management
- Develop appropriate, and further improve existing, incentive policies
- Develop new tools and mechanism such as energy efficiency labelling and energy and water conservation product certification to guide and provide sustainable consumption choices for consumers

In September 2006, China released its first assessment of the cost of pollution in the country. Based on the report, China's pollution caused USD $64 million worth of environmental damage (3.05% of GDP) in 2004. As a result, the government has called for more energy-saving and environmentally-friendly production to lower the costs in the future by the development of a new industrial path. China is the first country to assess a price on its pollution and its benefits are the creation of a model for developing countries as well as the advancement of public and business awareness.

Source: EKH-UNEP-RRCAP

HEALTHCARE WASTE

In China, healthcare waste has not been categorized into a special group yet, but it is listed as part of the hazardous waste although it is not mentioned in national statistics on industrial solid waste/hazardous waste (ISW/HW). According to National Catalogue of Hazardous Waste (1998), healthcare waste in hospitals and other medical treatment institutions are defined as either clinical waste, unused pharmaceuticals, used develop and fix. Even though this definition of healthcare waste exists in China, definition of categories corresponding to the hazardous nature of the different types of wastes, adequate disposal, and proper handling methods to facilitate a systematic healthcare waste treatment system is missing.

In total, about 10 million tons of hazardous waste was generated in 2002. Of this, 44% of hazardous waste was recycled, 27% was stored, 13.5% was disposed and 15.4% was discharged. Of the total hazardous waste generated, 40% was produced by the chemical materials and chemical products industry. High priority was given to medical waste after the outbreak of SARS, in 2002. The total amount of medical waste generated is about 650,000 tons (1,780 tons per day) and is projected to reach around 680,000 tons by 2010.

This is because hazardous waste regulations were nonexistent until the general provision under the Law on Solid Waste Pollution came into effect in 1996. The law mandates responsible treatment of hazardous waste and establishment of one site per locality for its management. Halfway through the year 1999 the State Council issued implementation guidelines for the Law in Solid Waste Pollution that also includes regulation on hazardous waste management.

At present, hospitals are required to dispose of and treat their healthcare waste by themselves and not centrally. According to the stipulations introduced in the early 90s, hospitals at and above county level should have their own incinerators installed within the hospital complex. About, 120 out of the 473 healthcare waste producers in Shanghai own an incinerator.

Findings

In China, hazardous waste treatment is still in its nascent stage. The incinerators used by the hospitals are small-scale ones designed for a burning temperature of 800°C. In practice, however, these incinerators cannot reach this temperature due to low quality, inadequate maintenance and short life expectancy. Furthermore, secondary pollution treatment facilities are also missing.

A field study in Shanghai reports that in most Shanghai hospitals the following methods for the disposal and treatment of healthcare waste are carried out:

- Disposable medical articles such as disposable syringes must be sent to Shanghai Sanitation and Anti-Epidemic station as required by the Shanghai Health Bureau.
- Organic waste/body parts (e.g. caecum) remaining from surgery are mainly burnt in crematories.
- Unused pharmaceuticals are sent back to the pharmaceutical companies.
- Used developer and fixer are either recycled by the "Yongsheng Metal Melting Factory" or collected by individual entrepreneurs. The branches of Shanghai Public security Bureau dispose other inflammable, explosive material and radioactive waste.
- Waste-recycling stations are responsible for disposing medical packaging materials.

According to State Environmental Protection Administration (SEPA), China, Shanghai Hazardous Waste Management Centre and Shanghai Environmental Protection Bureau, the major problems and challenges faced in managing healthcare waste are due to:

- Illegal Recycling of hazardous healthcare waste
- Poor regulatory framework and implementation guidelines
- Lack of enforcement of existing regulations leading to disposal of healthcare waste with municipal (household) waste or poor segregation of waste into clinical and general hospital waste
- Lack of technical guidance and missing definition of responsibilities of authorities in charge

- Weak infrastructure of disposal facilities and treatment technology and lack of expertise and understanding of alternative treatment choices and a comprehensive waste management philosophy
- Poor monitoring of waste generation
- Low quality of incineration equipment
- Unsafe collecting (and discharging) of developer/fixer
- Poor management in the centralized treatment and disposal of infectious articles

To cope with healthcare waste in the future, it is imperative to establish a comprehensive management system. The current system has a strong focus on the final disposal of the medical waste only, neglecting avoidance and utilization. Shanghai has already taken standard management measures on hazardous waste. However, its control on medical waste is just at the beginning. Up to now, hospital waste is either handled by each single hospital or centralized and handled by the Public Health Department or the Epidemic Prevention Department.

E-WASTE

Electronic waste provides another example of how China is being affected by global markets for recycled materials. In the US alone more than 40 million computers became obsolete in 2001, and as much as 80% of these were exported, mostly to China, at about a 10th of the price of recycling or disposal in the home country. Even today, tons of e-waste is imported in China. Currently, China is generating about two million tons of e-waste which comes from four main sources:

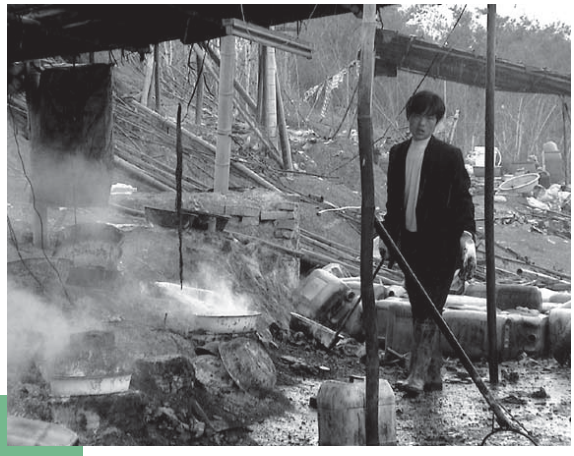
- Waste electronic products from households
- Waste electronic products from government institutions and enterprises
- Defective electronic products from manufacturers
- Imported electronic waste

The China Household Electrical Appliances Association estimates that Chinese households and companies throw out 15 million refrigerators, 10 million air conditioners, 18 million washing machines and 35 million computers every year. This data is based on an 8-to-10-year product lifespan. With e-waste still being smuggled into the mainland, many scientists estimate that the country will be unable to cope with the amount of hazardous waste generated, which results in severe secondary pollution.

Findings

The city of Guiyu, in the southern province of Guangdong, is the centre of an environmental disaster that has got out of control. Here and in several nearby townships; electronic waste, mostly imported is broken up in small workshops. It is a version of outsourcing that saves high cost of disposing of electronic trash and provides livelihood to many. In this part of China, recycling e-waste is apparently not subjected to any environmental, health, and safety regulations.

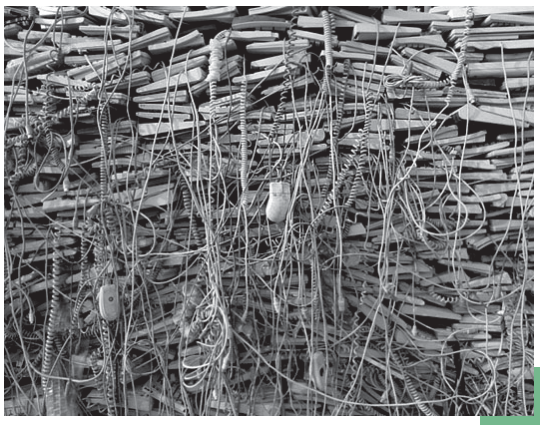
In small workshops, yards and open countrysides, poor workers handle hazardous wastes resulting from affluent lifestyles. Armed mostly with small hand tools, they take apart old computers, monitors, printers, video and DVD players, photocopying machines, telephones, mobile phones and chargers, music speakers, car batteries and microwave ovens. Chinese law forbids the importation of electronic waste and is a signatory to the Basel Agreement. E-waste imports have been so disorganized in China since 1996, but the country, considering the latent benefits, has turned a blind eye.



E-waste recycling – Guiyu town, Guandong Province, South China.
Image source: Basel Action Network 2006

More than 80% of the children in Guiyu town (known as e-waste terminus) suffer from lead poisoning and the general cancer rate is higher than average (The Nation Newspaper in Business Extra section, 2007).

E-waste recycling – Guiyu town, Guandong Province, South China.
Image source: Basel Action Network 2006



Stack of old keyboards (Nayang, 2005)
Wire stripping from discarded electronics
Image source: Natalie Behring /Greenpeace

Wire stripping from discarded electronics
Image source: Natalie Behring /Greenpeace

GAPS FOR IMPLEMENTATION OF 3R

Worldwide, experiences indicate that applying 3R is a lucrative way of tackling waste management issues. The first step in this exercise is an assessment of the technology options available for implementing 3R-based solutions. Proactive policies and relevant legislations emphasizing 3R-based solutions are vital to achieve a higher success rate form the next step. While recycling is considered as technological ability, reduce and reuse is often considered management or policy oriented. In this context, the following sections present information on the technology and management aspects with focus on recycling and reduce/ reuse, respectively.

TECHNOLOGY GAPS

With the initiation of Circular Economy, Waste Management has been the priority issue for most sectors. Local authorities have been facing tough situations in managing solid waste with the available technologies and human resources. In recent times, inorganic components and packaging waste has been dominating the urban waste streams. Priorities must be set to implement 3R technology options in either converting them to Plastic Derived Fuels or recycling them. For instance, the recent catalytic-pyrolysis reactor should be designed to suit the mixed waste plastics under small and middle scaled production. A novel and more efficient catalyst ought to be studied for the process of pyrolysis to catalytic-pyrolysis upgrade technique.

However, it is widely believed that applying appropriate technologies can result in effective solutions to the crisis. The status of technologies currently used in China with a special focus on 3R in urban municipal, healthcare and e-waste are given in the adjacent table.

MANAGEMENT ASPECTS

In China, the following strength and gaps were noticed after reviewing literatures and resources related to the Current Situation of National Policies, Legislative Measures and other Initiatives.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN CHINA

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	⭘
	Fuel Recovery	⭘
	Material Recovery	○
	Sorting	○
	Pulverizing	⊙
	Composting	⭘
	Incineration	●
	Collection	⭘
E-Waste	Material Recovery	○
	Sorting	⊙
	Pulverizing	⊙
	Collection	⊙
Healthcare Waste	Material Recovery	○
	Sorting	⊙
	Pulverizing	⊙
	Incineration	●
	Collection	⭘

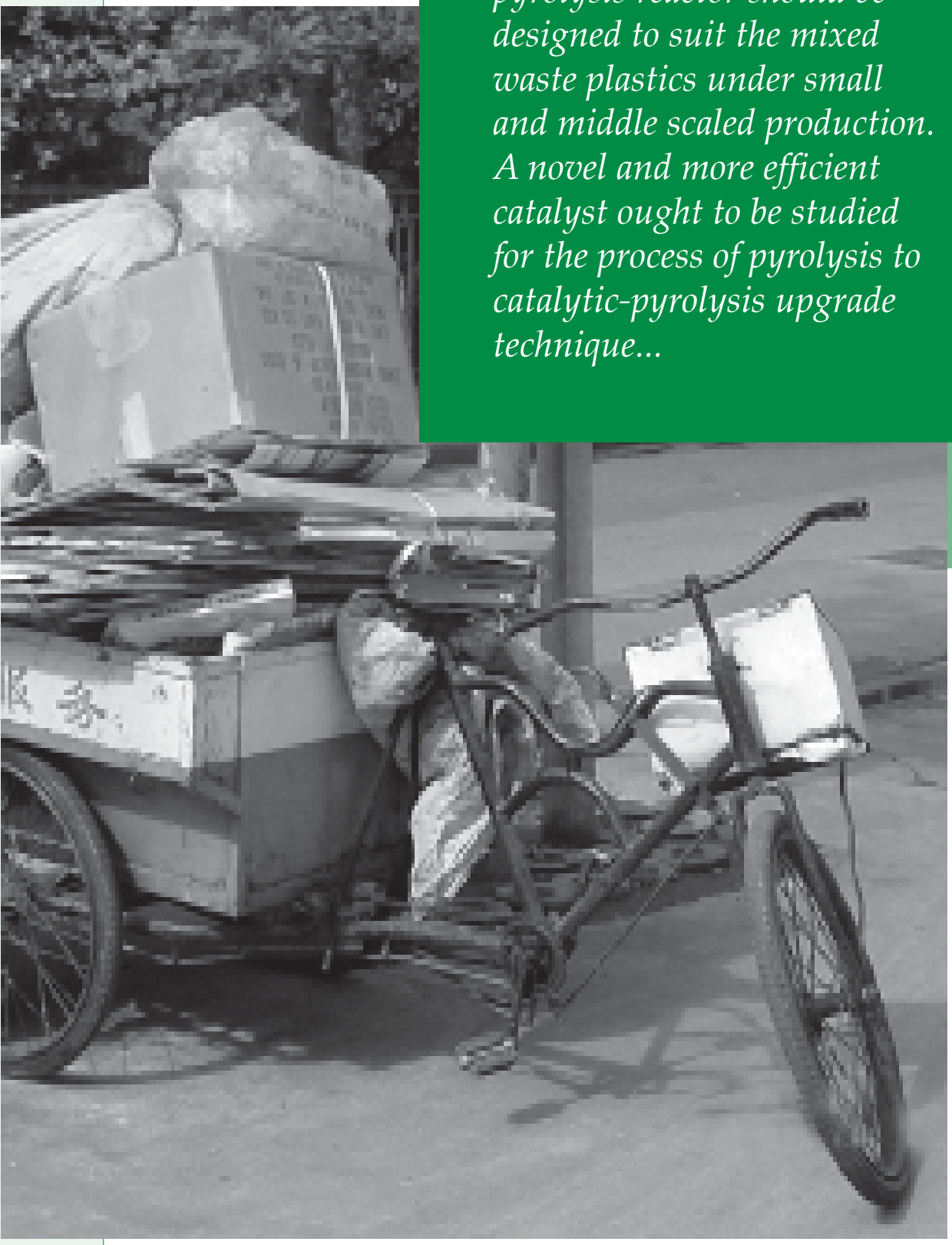
● Formal, Strong
⭘ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	Legal Framework for the Circular Economy Waste Management	○
	Direct Regulatory	Law on • Cleaner Production, 2002 • Environmental Impact Assessment • Prevention & Control of Environmental Pollution by Solid Waste, 2004 • Renewable Energy • Regulation on recycling of waste & old resources	○
	Economic	• Circular Economy • Incentives such as preferential tax policies are offered to organizations	○
	Voluntary	• Construction of Eco Industrial Parks • Environmental Labeling • Green Service & Consumption • Eco Industry • Eco-Agriculture	○
	Information	• Public Awareness • National Cleaner Production Center training courses • Pilot Projects at Industrial level • China International 3R Exhibition, 2005	○
	Procedural	Committee of the National People's Congress	☒
Support for 3R- related Activities		• State of Environmental Protection Administration • Central Government • Exchange and cooperation for Circular Economy with Japan and Germany	○
Environmental Education		• Development of Institution on Clean Production examination • Training courses on clean production organized by National Clean Production Center. • National Key Lab of eco- Industry set by SEPA.	○
Scienceand Technology		Promotion of research work research work on circular Economy Technology Development in Cleaner Production	○
Reduction of Barriers to International Flow		• Amendment to the Basel Convention implemented in China, 1999	○
International Cooperation		Technology exchange through international cooperation • Italy, World Bank Studies on "Legal Framework for the Circular Economy and Policies and Regulations for Promoting Development of Circular Economy in China ADB • Establishing an Environmentally Sound Technology Transfer Center Green Aid Plan, Japan Pilot Project :Reduce • National Cleaner Production (UNIDO/UNEP)	●
Cooperation of Stakeholders		• Cooperation among Asian countries and other stakeholders within the country	☒
Promotion of Science and Technology for 3R		• Promotion of research work on circular Economy • Technology Development in Cleaner Production	○

● Sufficient ○ Insufficient ☒ Gap

Priorities must be set to implement 3R technology options in either converting them to Plastic Derived Fuels or recycling them. For instance, the recent catalytic-pyrolysis reactor should be designed to suit the mixed waste plastics under small and middle scaled production. A novel and more efficient catalyst ought to be studied for the process of pyrolysis to catalytic-pyrolysis upgrade technique...



Various initiatives in bringing together all stakeholders of e-waste generation towards making joint efforts can be further eased and accelerated by introducing appropriate technologies. Implementing 3R principles in the handling of e-waste can yield immediate results...

3.6 India

BACKGROUND

Urbanization and uncontrolled population growth have made waste management a delicate issue in India. Though an essential service, management of waste has been gaining due priority only in recent years. Lack of financial resources, institutional weaknesses, improper choice of technology and public apathy towards waste management has made this service far from satisfaction. Current practices of uncontrolled dumping of waste on the outskirts of towns/cities has created serious environmental and public health problems. On the other hand, pollution from industrial wastes has rendered many places unlivable in the country. A comprehensive approach towards resolving waste management issues in India is the application of 3R.

A survey of information available to the public domain was performed to assess the gaps in implementing 3R in India. For this purpose, wastes from three major sources *i.e.* urban municipal, healthcare and e-wastes have been considered.

PRIORITY AREAS

An analysis of generation rate, current management practices and available technologies for waste handling and disposal in India identifies e-waste as a priority area. The Indo-German-Swiss joint research and action program on e-waste in India confirms the burning issue of e-waste. Various initiatives in bringing together all stakeholders of e-waste generation towards making joint efforts can be further eased and accelerated by introducing appropriate technologies. Implementing 3R principles in the handling of e-waste can yield immediate results.

Manual dismantling of Circuit boards
Image source: 3R S.A. Expert Workshop Proceeding, Kathmandu, Nepal 2006

URBAN MUNICIPAL WASTE

In India, Municipal Solid Waste Management (MSWM) is a part of public health and sanitation, and is the responsibility of the local administration. In recent years, MSWM has been assuming larger importance due to population explosion, legal interventions, emergence of newer technologies and rising public awareness towards cleanliness (Kumar et al., 2004).

Except in metropolitan cities, MSWM is the responsibility of a health officer who is assisted by the engineering department for transportation related work. The activity is mostly labor intensive, and 2-3 workers are provided per 1000 residents served. The municipal agencies spend 5-25% of their budget on SWM, which is Rs. 75-250 (USD 1.8–6) per capita per year (Kumar and Gaikwad, 2004). Normally a city with a population of 1 million spends around Rs. 100 million for this activity. In spite of this huge expenditure, services are not provided to the desired level (Kumar, 2005).

Plastic-tar roads in India

Domestic wastes falling into categories such as polyethylene, polypropylene and polystyrene or plastic carry-bags, disposable cups and PET bottles that are collected from garbage dumps are now important ingredients of construction materials.

When mixed with hot bitumen, plastics melt to form a coat over the aggregate and the mixture is laid on the surface like a normal tar road. Use of shredded plastic waste acts as a strong binding agent for tar making the asphalt last long. By mixing plastic with bitumen the ability of the bitumen to withstand high temperature increases. Plastics can be mixed with heated tar and later mixed with the gravel. Polyethylene can be used up to 5% and polystyrene 20%.

Plastic waste is melted and mixed with bitumen in a particular ratio. Normally, blending takes place when temperature reaches 45.5^{0}C but when plastic is mixed, it remains stable even at 55^{0}C. Durability of the roads laid with shredded plastic waste is more compared to those asphalted with the ordinary mix. The binding property of plastic makes the road last longer besides giving added strength to withstand more loads.

While a normal highway-quality road lasts four to five years it is claimed that plastic-bitumen roads can last up to 10 years. The bitumen mix-plastic flakes roads resist against water seepage due to the presence of plastic and resulting to lesser road repairs. Each kilometer of road with an average width requires over two tons of poly-blend-substituting the same with waste plastic will help to reduce the plastic waste.

The cost of plastic road construction may be slightly higher compared to the conventional method. However, this should not deter the adoption of the technology as the benefits are much higher than the cost.

Salem town shows the way to handle plastic waste

Salem, an industrial town in Tamil Nadu, is the first to lay a plastic-tar road in the country. The technology becomes one of the solutions for plastic waste management in India. This project is a combined effort of the Salem Municipal Corporation, Corporators, the Exnora Club, an NGO and the plastic manufacturers. There are more than 12 roads laid using plastic waste in Tamil Nadu alone. Other than Tamil Nadu, Karnataka and Maharashtra have also utilized the technology for using waste plastic in shredded form in road construction.

Source: The Tribune and ICPE

Quantity and characteristics are two major factors, which are considered as the basis for the design of efficient, cost effective and environmentally compatible waste management system. Studies have revealed that quantum of waste generation varies between 0.2-0.5 kg/capita/day in the urban centers and it goes up to 0.6 kg/capita/day in metropolitan cities.

The urban local bodies spend approximately Rs. 500 to Rs. 1,500 (USD 12–36) per ton on MSW for collection, transportation, treatment and disposal. About 60-70% of this amount is spent on collection, 20-30% on transportation and less than 5% on final disposal. Out of the total MSW collected, an average of 94% is dumped and a meager 5% is composted (Disha and Thanal, 2001).

MSW dumpsites in Chennai (India)
Image source: 3R S.A. Expert Workshop Proceeding, Kathmandu, Nepal 2006

The socio-economic structure of our society not only makes per capita generation of waste much less compared to that of the western societies, it also brings a system of waste recycling and reusing not common in developed societies. A substantial amount of MSW is recycled and reused through the primary intervention of ragpickers and secondhand markets, though there are problems like health hazards to the rag pickers and the degradation and devaluation of the recyclable materials.

Findings

The urban population of 285 million concentrated in a few large cities and 32 metropolitan cities and accounts for 34.5% of the total population. It is expected to reach 341 million by 2010 (Census of India, 2001). The waste quantities are estimated to increase from 46 million tons in 2001 to 65 million tons in 2010 (Kumar and Gaikwad, 2004).

Waste characteristics are expected to change due to urbanization, increased commercialization and standard of living. The present trend indicates that the paper and plastics content will increase while the organic content will decrease. The ash and soil content is also expected to decrease.

Composting is the process of decomposition and stabilization of organic matter under controlled conditions. Since India is an agriculture-based country, there is a need for popularization of compost production among the farmers and exploit the value of the product.

Waste minimization, through segregation of recyclable materials such as plastics, glass and metals is another aspect, which needs immediate attention. NGOs may come forward to promote the activity. Waste pickers may be trained so that the segregation of recyclable items can be done in a more systematic and organized manner.

HEALTHCARE WASTE

Healthcare waste management in India has been receiving greater attention due to recent regulations *i.e.* Biomedical Wastes Management & Handling Rules, 1998. The prevailing situation was analyzed, covering various issues like quantities and proportion of different constituents of wastes, handling, treatment and disposal methods in various healthcare units, and indicates that the waste generation rate varies between 0.5 and 2.0 kg/bed/day (Patil and Shekdar, 2001). It is also estimated that about 0.33 million tons of healthcare waste is generated in India every year. Solid waste from the hospital consists of bandages, linen and other infectious waste (30–35%), plastics (7–10%), disposable syringes (3–5%), glass (3–5%) and other general wastes including food (40–45%).

Except a few places, wastes are collected in mixed form, transported and disposed of along with MSWs. At many places, authorities are failing to install appropriate systems for a variety of reasons, such as non-availability of appropriate technologies, inadequate financial resources and absence of professional training on waste management.

Healthcare waste is a serious problem in India, where ragpickers get exposed through contaminated hospital garbage to recover the glass, paper, plastic and metal that they can sell for recycling. To protect them and others who could easily find and reuse contaminated needles and other medical supplies, a safe system of disposing of medical waste is urgently needed.

Findings

Healthcare waste technology market is seeing a steady influx of alternate technologies. There are already a number of autoclave, hydroclave and microwave technologies available. Centralized and shared waste treatment facilities are now being allowed within legislation, also because of NGO promotion. Centralized facilities allow not only for more state-of the art facilities to be installed, but also help in ensuring that these adhere to regulatory norms. Instead of resource strapped pollution control bodies (monitoring individual stacks in hospitals), centralized facilities reduce this to a few in the city. Economies of scale allow for more cost effective technologies and capacities, besides running in a scientific manner through trained staff. Considering that a small percentage of healthcare waste, consisting of mostly pathological wastes and body parts, needs to be incinerated, this can be carried out by sharing the many existing incinerators in a city. A zonal or centralized autoclave or microwave disinfecting unit can then take care of the rest of the waste.

Healthcare waste management is not only a technical problem, but is also strongly influenced by economic conditions. On its own, enactment of legislation will not make it more efficient. Sustainable solutions can be achieved only by involving local bodies engaged in waste management and making sure they follow the principles of effective management. Healthcare waste should be subjected to disinfection and mutilation prior to reuse, recycling or disposal. Precautions have to be taken so that disposable items like needles, syringes, intravenous sets and other plastic items are not reused. Efforts have to be made for minimizing waste. An appropriate plan has to be evolved as per the prevailing conditions. Instead of incinerating their waste, hospitals should:

- phase-out the use of PVC plastics and mercury products;
- reduce, segregate and recycle as much waste as possible;
- shred contaminated waste for volume reduction and avoid reuse, and then sterilize the material using high temperature steam or microwaving before disposal in dumpsites.

E-WASTE

The government, industry, users and NGOs have taken notice of the growing hazards of e-waste and reached a consensus that recycling and resource recovery has to be environmentally compatible.

A national Waste Electrical and Electronic Equipment (WEEE) Task Force was formed in July 2004. Headed by the Chairman Central Pollution Control Board (CPCB), the Task Force consists of representatives from relevant Government Departments, Ministry of Information Technology, Regulatory Agencies (representatives of SPCBs), NGOs, Industry Associations, experts and producers.

The mandate of the National Task Force is to identify, plan and implement all issues related to e-waste in India. The National WEEE Task force has five thrust areas: Policy and Legislation, Baseline Study, Restructuring and Recycling, Extended Producer Responsibility and Awareness Building.

The first comprehensive study to estimate the annual generation of e-waste in India is being undertaken by the National WEEE Taskforce. So far, the preliminary estimates suggest that total WEEE generation in India is approximately 146,000 tons per year. The top states in order of highest contribution to WEEE include Maharashtra, Andhra Pradesh, Tamil Nadu, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab. The city wide ranking of largest WEEE generators is Mumbai, Delhi, Bangalore, Chennai, Kolkatta, Ahmedabad, Hyderabad, Pune, Surat and Nagpur.

Approximately 30,000 computers become obsolete every year from the IT industry in Bangalore alone. The reason is an extremely high obsolescence rate of 30% per year.

Almost 50% of the personal computers sold in India are products from secondary markets and are re-assembled on old components. The remaining market share is covered by multinational manufacturers (30%) and Indian brands (22%).

Three categories of WEEE account for almost 90% of the generation, large household appliances (42.1%), information and communications technology equipment (33.9%) and consumer electronics (13.7%).

The Government of India has reiterated its commitment to waste minimization and control of hazardous wastes, both nationally and internationally.

The Basel Convention on the control of Transboundary Movement of Hazardous Wastes and Disposal was signed by India on 15th March 1990, ratified and acceded in 1992. A ratification of this convention obliges India to address the problem of transboundary movement and disposal of dangerous hazardous wastes through international cooperation. As per the Basel Convention, India cannot export hazardous wastes listed in Annex VIII of the Convention. However, the convention agreement does not restrict the import of such wastes from countries that have not ratified the Basel Convention. It is through the orders of the Honorable Supreme Court that the import of such wastes is now banned in the country.

The legal basis therefore is regulated in the Hazardous Waste Management and Handling Rules (1989/2000 amended and subsequently in 2003). This document also controls the import of hazardous waste from any part of the world into India. However, import of such waste may be allowed for processing or reuse as raw materials. There is no specific legislation pertaining to the management of e-waste so far.

Findings

Formal e-waste recyclers are in a nascent stage, with the first ones being established in Bangalore. Currently, the collection, dismantling and recovery are done entirely by a well-established network in the informal sector. Even though the sector creates substantial value addition, especially by collecting and repairing unused equipment, some recovery processes employed are extremely dangerous.

Trade in e-waste, like that in other scrap, is dominated by the informal sector. The waste trade sector in India, known as a part of the informal sector, has a system that is highly organized with extensive coordination in an established network. However, e-waste recycling is undertaken in a very unscientific manner, impacting both health and environment.

GAPS FOR IMPLEMENTATION OF 3R

Worldwide experiences indicate that applying 3R is a lucrative way of tackling waste management issues. The first step in this exercise is an assessment of the technology options available for implementing 3R-based solutions. Proactive policies and relevant legislations emphasizing 3R-based solutions are vital to achieve a higher success rate form the next step. While recycling is considered as a technological ability, reduce and reuse is often considered management or policy oriented. In this context, the following sections present information on the technology and management aspects with focus on 3R.

TECHNOLOGY GAPS

Waste Management has been the foremost issue for local administration bodies in the country. Continuously increasing quantities and inconsistent composition of the waste are some of the barriers to the effective implementation of management practices. However, it is widely believed that applying appropriate technologies can result in effective solutions to the crisis. In this context, the table below presents the status of technologies currently used in India, with a special focus on 3Rs in urban municipal, healthcare and e-waste.

MANAGEMENT ASPECTS

With a vast and diverse nature of State and Central Governments, it is essential that the right management measures are taken to collect, treat and dispose waste in an environmentally friendly way. In a federal setup adopted by India, proactive polices are key to the effective implementation of any result-oriented program. Waste management is no exception to this. Though various measures are currently being taken-up by the relevant ministries, it is important that the 3R principles be integrated into these to make the reach wider. An overview of present policy, legislative and other management measures in India with a 3R perspective as a means of solving the waste management crisis is presented in the adjacent Table.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN INDIA

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	⊙
	Fuel Recovery	⊙
	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Composting	⊙
	Incineration	⊙
	Collection	⊙
E-Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	○
	Collection	⊙
Healthcare Waste	Material Recovery	○
	Sorting	⊙
	Pulverizing	○
	Incineration	●
	Collection	⊙

● Formal, Strong
⊙ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	**Framework**	National Environmental Policy, 2005	○
	Direct Regulatory	• Solid Wastes (Management & Handling) Rules, 2000 • Plastic Manufacture &Use Rules, 2003	○
	Economic	ADB promoting grant	○
	Voluntary	Voluntary Initiatives by Government & Industry • Promotion of Cleaner Technology & Waste Minimization • Charter on Corporate Responsibility for Environmental Protection	○
	Information	Lack of specific information instruments	☒
	Procedural	Lack of specific environmental quality surveillance instruments	☒
Support for 3R-related Activities		Government of India	☒
Environmental Education		No emphasis on environmental education	☒
Science and Technology		• Promotion of clean technology • Waste minimization circles in small and large-scale industries • Regulated activities of import & export of hazardous and non-hazardous waste	○
Reduction of Barriers to International Flow		• India will not violate international treaties, like the Basel Convention, 16 June 2006	○
International Cooperation		Information sharing, Training, Public Awareness • Green Aid Plan, Japan • National Cleaner Production, UNIDO/UNEP ADB • Management of hazardous waste with a grant of USD 400,000 with technical assistance	○
Cooperation of Stakeholders		Lack of cooperation among the stakeholders within the country	☒
Promotion of Science and Technology for 3R		• Under implementation level	☒

● Sufficient ○ Insufficient ☒ Gap

Only a few large-scale enterprises comply with environmental standards and have 3R principles in place. The solid wastes generated are mostly organic. With only 40% collection efficiency, the waste is often open burned, abandoned or left to rot in sewers and abandoned places. The collected waste is dumped at designated dumpsites with minimal or no pretreatments.

Local scavengers at dumpsite
Image source: Muhammad Zakaria, 3RKH Inception Workshop, Hanoi 2007

3.7 Indonesia

BACKGROUND

Indonesia, with over 18,000 islands, spans almost 2,000,000 km^2 between Asia and Australia, and has a population of about 246 million living on a land area of about 1,830,000 km^2. Indonesia has revealed high population growth with a parallel rise in economic development and prosperity and the country has managed to achieve a per capita GDP of about USD 3700 (2005). Around 43.6% of the GDP is generated through the services sector with nearly 46.5% employed in the agriculture sector. The present annual real GDP growth is nearly 5.6 % (2005) after the economic crisis in 1997.

PRIORITY AREAS

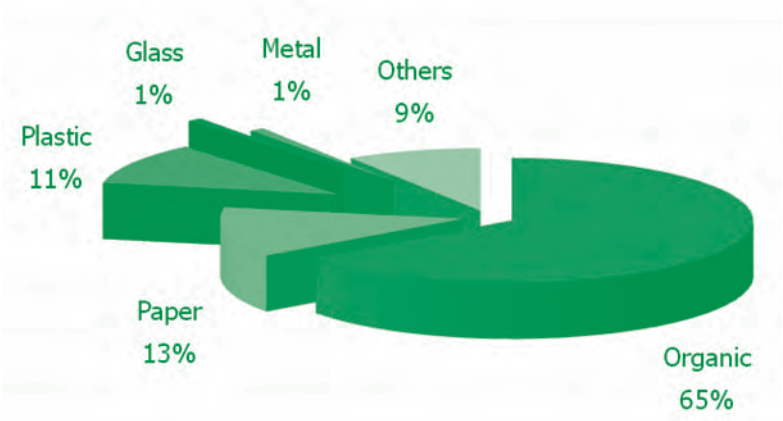
With more than 40 million micro, small and medium enterprises lacking proper waste treatment facilities and over 8000 large enterprises, the solid waste generated poses a huge challenge to the authorities. Only a few large-scale enterprises comply with environmental standards and have 3R principles in place. The solid wastes generated are mostly organic. With only 40% collection efficiency, the waste is often open burned, abandoned or left to rot in sewers and abandoned places. The collected waste is dumped at designated dumpsites with minimal or no pretreatment. Thus, it is clear that management of municipal solid waste takes priority.

URBAN MUNICIPAL WASTE

Urban municipal waste has been largely dominated by organic fractions, which in turn requires very efficient collection systems to avoid odor and hygiene problems. Like other developing countries, lack of budget allocations and waste management strategies further makes this collection task even more difficult, except for a few urban centers like Jakarta where the overall solid waste collection efficiency was recorded higher than 80%. With domestic waste increasing at a rate of 2-4% per year, the most common method of waste treatment or disposal is still open dumping. Even though recycling activities and composting practices are observed, they only contribute to a very small portion covering 1.6% of the total waste.

Daily collected recyclable waste from domestic areas
Image source: Muhammad Zakaria, 3RKH Inception Workshop, Hanoi 2007

Heap of Urban Refuse, Bandung City
Image source: Muhammad Zakaria, 3RKH Inception Workshop, Hanoi 2007



Municipal Waste Composition - Indonesia
Source: www.3rkh.net

Organic Waste Management in Surabaya

The daily waste generation in Surabaya city is around 1630 ton and a major portion is from household units which contribute around 56% organic waste. The foremost challenge in Surabaya City is in implementing 3R. Recycling has been carried out by scavengers, which has often led to exposure of solid waste on streets and sanitation problems. Normally, scavengers reduce solid waste volume by almost 30% in Surabaya, which greatly reduces costs of transportation and disposal downstream. So there is an emerging need to manage an efficient recycling system involving the scavenger labor force.

Another obvious challenge for Surabaya is the large gap between income and expenses in solid waste management. Semi-sanitary landfills, composting and small scale incineration have been the key components in the final treatment. Expenses are subsidized from other sources such as tax and other city revenue. Appropriate strategies have been envisaged to ensure participation and involvement of the community, which, in turn, promotes self-development of the community itself. However, law and regulations must be improved together with human resources in order to facilitate effective management. Furthermore, due to a lack of institutional framework and rules and regulations, private sector participation in solid waste management is limited. The crucial innovative strategy from Surabaya is the "Kampung Improvement Programme (KIP)" and "Comprehensive Kampung Improvement Programme (C-KIP)", with the focus on empowering local communities to solve their own problems in solid waste management with the support from the local government and professionals. In this arrangement, local communities are responsible for solid waste management in their neighborhood. Under this arrangement, households pay transport and disposal charges for solid waste management to the city government, either through water bills or at the subdistrict level.

Source: Solid Waste Management Seminar Kitakyushu, September 2002.

There has been a significant progress in Indonesia with respect to solid waste management and 3R implementations, especially in agro-industries.

- Slaughter House - compost, biogas & methane capture - electricity
- Milk Industries - compost
- Sugar Plant - compost, bio-fuel
- Palm Industries - compost, bio-fuel, Forestry and Horticulture - bio-fuel

The Compost Subsidy Project in 19 cities has proved to be successful, especially in Bandung city. The municipalities in Bandung city have put forward a plan to implement 3R initiatives in managing their solid waste problem. Prior to landfills, the collected waste would pass through temporary treatment sites, one at the community level and the other at the city level. These treatment sites will segregate the organic waste for composting and inorganic materials for recycling. The residues would be sent either for further treatment or landfilling. Residential areas, markets, offices and transportation terminals have been identified as main sources of waste generation. The 3R approach would be channelled from Local Community to NGO to the Government (Local–Provincial– Central).

The Compost Subsidy Project plans to reduce 20-40% of the solid waste generated before reaching the landfill site. A different scenario has been reported in Surabaya and Jakarta where environmental cadres are engaged to ensure the proper management of waste. These cadres are mostly from nearby schools or universities. This comprehensive program has showed remarkable progress in managing household solid waste through segregation and community level composting. This program also promoted waste awareness and green concepts by organising a 'Go Green School Program' where different schools compete for "environmentally sound schools".

HEALTHCARE WASTE

In most cases, a large percentage of healthcare waste is classified as general waste and disposed in municipal dumpsites. To minimize the risk to public health, waste segregation as well as infectious waste treatment prior to disposal needs to be conducted properly by the hospital management, especially when scavenging takes place in dumpsites.

Representatives from the Government of Indonesia maintain that the mission of the healthcare waste program is to reduce and prevent as much as possible the production of healthcare waste and treat it in an appropriate manner to prevent environmental pollution and adverse health impacts. The basic principle of healthcare waste management is that healthcare institutions, as generators of waste, have an obligation to manage and prevent the impacts that may be caused by the waste, either in terms of costs, or in terms of any sanctions to meet the requirements of the law.

Findings

In 1992, the Ministry of Health issued Regulation No. 986 along with the National Standard and Guidelines for Hospital Sanitation Management including healthcare waste management. Subsequently, in 1994, the Government issued Government Regulation No. 19 dealing with the management of hazardous wastes. Some of the basic elements were the obligation of the hazardous waste producers to treat the hazardous wastes and in case that the producer does not have the capacity or the equipment to treat the waste, then the producer must assume the responsibility to transfer the waste to a treatment center and to pay for any costs associated with the transportation and treatment required. However, the major stumbling block is the implementation of this law and regulations due to the lack of strict provisions in the law.

There is a strong need to develop a consistent approach to healthcare waste management. Necessary steps have been taken to implement a long-term program to conduct an action research in developing a network for hazardous waste collection. The level of public awareness in the healthcare waste management is still in the preliminary stage. World Health Organization, Indonesia with support from the European Commission's Humanitarian Aid Office (ECHO), helped the local authorities implement the project 'Clinical Waste Management in the Earthquake and Tsunami Affected Area of Northern Sumatra'. From past records, it is not clear how much healthcare waste is generated in Indonesia.

Community waste collection, Kampung Sukunan Yogyakarta
Image source: Muhammad Zakaria, 3RKH Inception Workshop, Hanoi 2007

E-WASTE

Preliminary research by the Basel Action Network reveals that besides China, most e-waste exports are to Indonesia, India and Pakistan where they are processed in operations that are extremely harmful to human health and the environment. Even as the domestic electronic waste issue remains unattended, the export of hazardous waste such as outdated printed circuit boards, floppies and tons of copper sludge is going on in connivance with the authorities.

It is common in Indonesia that domestic e-wastes are mixed with general waste and managed by the domestic waste handling system.

Findings

The Basel Convention Regional Centre for Southeast Asia (BCRC-SEA) is currently conducting an e-waste technical guidelines development project (E-Waste TGLDP), consisting of two parts; Inventory and ESM 5R of e-waste. One of the objectives of the project is to develop guidelines to provide information and serve as guidance for implementation of inventory and 3R and repair/refurbishment of e-waste by parties in the region.

The type of e-waste to be assessed are those in the primary form, i.e., the ones generated from (discarded by) first users in its originally manufactured or intended form. The main groups of e-waste types under the project are:

- Electronics
- Personal Computers
- Cathode Ray Tubes
- Television Sets & Personal Computer Monitors

E-Waste Recyclers
Image source: Dan WHS (2006) – BCRC-SEA

- Cellular Phones
- Electrical Home Appliances
- Home Air Conditioners
- Dry Power Batteries
- Fluorescent Lamps

It has been recognized that the application of Extended Producer Responsibility and Corporate Social Responsibility is a vital tool in combating the growing e-waste. Moreover, open collection point of package wastes were incorporated with recycling, processing and demolishing purposes. At the government level, it has proposed to develop consensus regarding e-waste handling with the Chamber of Commerce and Department of Industries.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN INDONESIA

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	☒
	Fuel Recovery	☒
	Material Recovery	○
	Sorting	○
	Pulverizing	☒
	Composting	○
	Incineration	⊙
	Collection	⊙
E-Waste	Material Recovery	☒
	Sorting	⊙
	Pulverizing	☒
	Collection	☒
Healthcare Waste	Material Recovery	◍
	Sorting	☒
	Pulverizing	☒
	Incineration	☒
	Collection	☒

● Formal, Strong ⊙ Informal, Weak ☒ Technology Gap
◍ Formal but weak ○ Informal but Strong

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	• National Policy on Cleaner Production, 2003	○
	Direct Regulatory	• Environmental Management Act, 1997 • Domestic Solid Waste Management Act, 2006 (Draft)	○
	Economic	• Soft Loan For MSMEs, 1990 • Composting Subsidy Project, 2004	○
	Voluntary	Voluntary Initiatives by Government & Industry • Environmental Performance Rating for Big Enterprise, 1993 • Cleaner Production, 1995 • Eco-office Program, 2003 • Eco Label, 2004	●
	Information	• Clean and green Cities Program, 1986 • Clean River Program, 1989 • Blue Sky Program, 1993 • Early-age Environmental Program, 1999	○
	Procedural	No specific Procedural System	☒
Support for 3R-related Activities		• Ministry of Environment • Industries, Local Government & Universities	○
Environmental Education		• Early-age educational Program for Children • ACIL webpage: Good Practices for children • Green Campus Program • Eco-office Guidelines	●
Science and Technology		• Implemented Environmental Sound Technology (EST, 2003-2007) • Eco-Industrial Estate Development • Cleaner Production Implementation in Palm Oil Industry	○
Reduction of Barriers to International Flow		• Waste Management Bill for recycled and manufactured wastes • Policies and Programs development for waste minimization. • Amendment to the Basel Convention, 2002	●
International Cooperation		• 3R National Strategy Formulation (UNCRD) • Green Aid Plan (Japan) • Industrial Efficiency & Pollution Control Project (Germany) • Waste-to-Product Partnership Program (US-AEP) • Produkish Project (GTZ) • Sharing of experiences & capacity building :ASEAN Cooperation, International Cooperation (NORAD, GTZ, JICA, CIDA, World Bank, ADB, etc.), GEF Composting Grant • Soft Loan for Small & Medium Enterprises, infrastructure provision: MDGs as a basis for 3R, • The UN Marrakech Process: Public Campaign (Green School), Promoting EPR, Environmental Forum, Provincial & Local Environmental Strategy.	●
Cooperation of Stakeholders		• Promoting champions on 3R initiatives at community level Competition on 3R for Woman Group, Youth, and student • Encourage and creating conducive environment for 3R local Initiatives :Village : Rawajati, Banjarsari, Sukunan,etc • Public Private Partnership :Green Cities Green Communities, Energy Globe (CSR/CDP) • Education and Campaign ,Information sharing on technologies and best practice	●
Promotion of Science and Technology for 3R		• Research and Development (University, Research Center, NGO) • Indonesian Cleaner Production Center (MoE, Ministry of Industry, NGO, etc) • CDM (MoE)	○

● Sufficient ○ Insufficient ☒ Gap

Though Japan has been able to successfully implement a 3R-based society, its industrial waste is still at stake posing grave threats. Therefore, it is essential that the industrial waste in the country be treated and handled with top priority towards achieving a holistic, closed material cycle country...

3.8 Japan

BACKGROUND

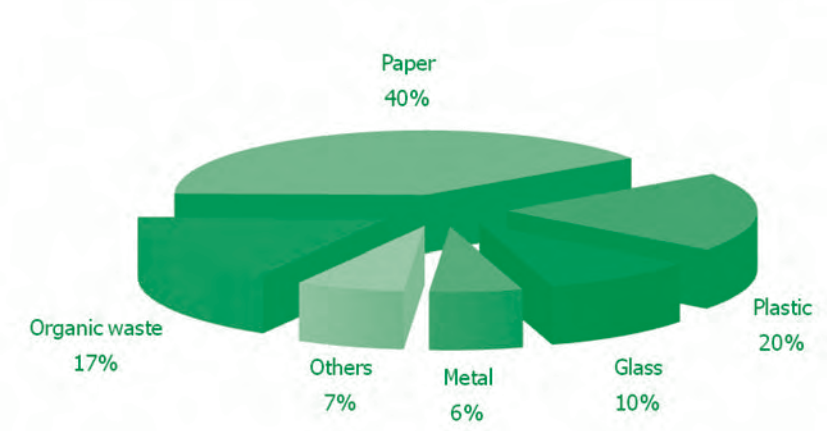
Located in the Pacific Ocean with a population of about 127 million Japan has a total land area of about 380,000 km^2. The per capita GDP of the country is estimated at US$ 33,100. Excellent government-industry cooperation, strong work ethics, and mastery of high technology, has helped Japan become the second most technologically powerful economy in the world. Japan's industrial sector is heavily dependent on imported raw materials and fuels.

With limited land and resources, the country is still a leader among the Asian countries. The Government of Japan, with its proactive initiatives, has been able to cope with resource constraints while leading the market in all walks of life. The 3R initiative, itself is considered as the brainchild of Japan.

PRIORITY AREAS

After the economic recession in the last decade, the Japanese government's main concern was to advance its economic development resulting in policy-enhanced mass production. As a result, the amount of discharged waste increased every year and disposal sites were predicted to be full in a few years. This situation led the Japanese government to shift their policy and make the society more environmentally sound. The Fundamental Law for Establishing a Sound Material-Cycle Society was enacted in 2000. Following this several laws concerning recycling were enacted and enforced. Subsequently, the 3R policy was enacted to create a sustainable society. Despite Japan's movement toward a closed loop, recycle-based society, the amount of industrial waste has remained at around 400 million tons per year during the last 10 years.

An issue that has become the focus of Japan is the disposal of its industrial waste. The Waste Management and Public Cleansing Law of 1970 regulates the methods of disposal of certain wastes emitted by factories and businesses, such as soot, sludge, waste oil, discarded plastic, and other wastes. Industrial wastes discharged in Japan amounted to 412 million tons in fiscal 2003, which is about eight times the volume of general waste from homes and offices. Though the country has been able to successfully implement a 3R-based society, its industrial waste is still at stake posing grave threats. Therefore, it is essential that the industrial waste in the country be treated and handled with top priority towards achieving a holistic, closed material cycle country.



MSW Composition in Japan
Source: www.3rkh.net

URBAN MUNICIPAL WASTE

Over 51 million tons of municipal waste contributes to the waste stream, at an average generation rate of nearly 1.14 kg/capita/day. The waste is segregated into general waste and recyclable waste and is collected separately.

The collected general waste is sorted as combustible and bulky. While the combustible waste is sent directly to waste incinerators, the bulky items are compacted before they are sent to the waste incinerators . At the incinerators, the waste is burnt under controlled conditions and energy is recovered from the heat generated. The waste reduced to ash, is then disposed at a landfill site.

Estimates show that landfill sites in Japan will last only another 12 years with current municipal waste generation patterns. As a result, Japan is forced to recover a variety of materials through kerbside recycling collection schemes, recovery of recyclable ferrous metals from bulky waste items and through electrical appliance recycling (where televisions, refrigerators, washing machines and computers are recovered for recycling).

Considering the growing need to accelerate recycling as a means of solving the waste management crisis, the Government of Japan established Eco-Towns in 1997.

MSW Disposal in Japan
Source: www.3rkh.net

In addition, various laws emphasizing recycling and reuse were enacted. As a result, the actual amount of waste to landfills has been greatly reduced after 2000, and Japan was able to achieve the highest level of resource productivity.

Findings

Before the creation of eco-towns and the enactment of recycling and reuse oriented laws, general waste was classified as combustible, noncombustible, bulky and recyclable and treated separately. Incineration and landfills were the most preferred modes of disposal, thus creating problems of growing shortage of landfill sites. There has been reduction in waste sent to landfills since 1990 due to promotion of the legislation “Fundamental Law for Establishing a Sound Material-Cycle Society”.

Eco-Town at Kitakyushu in Japan

The Eco-Town Project introduced by the Ministry of Economy, Trade and Industry (METI) of Japan in 1997 aims to promote a "Zero Emission Society" at local and national levels by creating new environmental towns and introducing advanced technologies for recycling. METI promotes this project to local governments and provides subsidies for the construction of high-tech model recycling facilities and for marketing efforts in the environmental industry.

Kitakyushu Eco-Town, located in the eastern part of the Hibiki landfill area in the city of Kitakyushu, is the first of the approved projects and the most symbolic. The project consists of a Comprehensive Environmental Industrial Complex, the Hibiki Recycling Area, and a Practical Research Area.

The Comprehensive Environmental Industrial Complex houses recycling projects on Plastic PET Bottle, Office Equipments, Automobiles, Home Appliances, Fluorescent Tubes, Healthcare Wastes and Construction Wastes.

The Hibiki Recycling Area contains diverse zones varying from an Automobiles Recycling to Cooking Oil and Fat, Detergent and Organic Solvent, Waste Plastic, Used Paper into Livestock Litter and Empty Can Recycling Project in the Frontier Zone.

The Practical Research Area aims to promote the research and development of cutting-edge environmental technologies, by mobilizing various research organizations to demonstrate recycling and waste treatment technologies.

Source: Kitakyushu Eco-Town Project

The local communities play an active role in promoting the community-based recycling activities. Notably, Japan stands as one of the highest in used paper recycling rates in the world.

HEALTHCARE WASTE

The generation of healthcare waste in Japan has been reported at 1.2kg/bed/day. Total hospital waste generation in Japan was estimated at about 150,000 tons. Incineration is found to be the most popular method of treating hospital waste. Incinerator capacities vary from 0.08 to over 200 tons/day. The majority of incinerators have a capacity of less than five tons/day. Apart from incineration, slagging, and high-pressure steam sterilization, dry heat sterilization is also practiced, to a smaller extent, to treat healthcare wastes.

Healthcare waste treatment in Japan

	Method of Treatment	Contractors
1	Incineration	360
2	Slagging	7
3	High pressure steam sterilization	3
4	Dry heat sterilization	6
5	Others	6

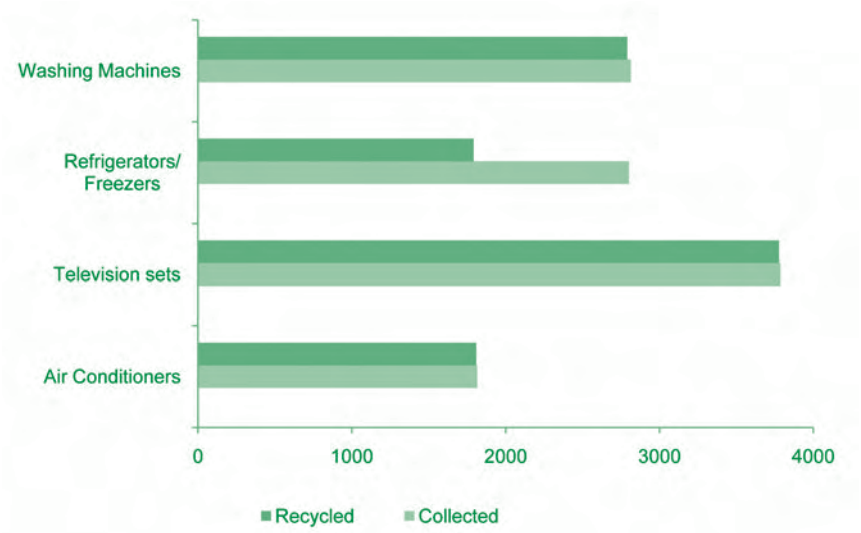
In Japan, the Waste Management and Public Cleansing Law stipulates that hospitals, clinics and other medical institutions are legally responsible for the management of their waste in a manner specified by the law. Infectious waste is legally defined as waste requiring special control. Most hospitals and clinics contract licensed private companies. The healthcare waste generation in 2000 amounted to 149,077 tons in total, and the most popular method of treating healthcare waste is incineration, as shown in Table above.

The law requires operators of any incinerator with a capacity of 200kg/hr or more to obtain a construction permit.

Findings

Japan has been actively progressing in the recycling and reuse of e-waste and other components of household waste. Various laws and attractive policies enforcing, recycling and reuse in the above waste categories are also in place. A systematic approach has been followed in treating the waste from these sources.

Nevertheless, wastes from healthcare businesses do not appear to have been adequately addressed. All initiatives focus only on the general waste from municipal sources. Very little information, insufficient to make a conclusion, on 3R initiatives targeting healthcare wastes is available.



E-Waste Recycling in Japan
Source: www.3rkh.net

Personal Computer Recycling in Japan

Waste Type	Collected ('000)	Recycled ('000)	Recycling Rate %
Desktop PCs	4600	3220	70
Notebook PCs	6400	2560	40
CRT Displays	9150	6680	73
LCDs	2250	1440	64

E-WASTE

In 2001, Japan implemented a recycling system for television sets, refrigerators, washing machines, and air conditioners under the Home Appliance Recycling Law. Recycling and transportation fees are paid by consumers, and discarded appliances are sent to recycling facilities. Japan's Law for Promotion of Effective Utilization of Resources (often referred to as the Recycling Promotion Law) was enacted in 1991 to promote increased recycling of a variety of products and materials. One of the major goals of the law was the promotion of product designs that facilitate waste reduction, recycling, and reuse. In 2001, the law was revised to address personal computers. It is estimated that 51% of households in Japan own personal computers accounting for a total of 24 million units. This revised law embraces the principle of Extended Producer Responsibility (EPR) by requiring manufacturers to establish collection and recycling systems for used computers. The revised law requires manufacturers of small batteries and electronic products that contain them to establish a recovery system for rechargeable batteries, including nickel-cadmium, nickel-metal hydride, lithium-ion, and small sealed lead-acid batteries.

Findings

Apart from the level of recycling, various other estimates put the number of Japanese white goods dumped in rivers or at the side of roads at around 20 million a year. Under Japan's Specified Home Appliance Recycling (SHAR) Law, enacted in 1998 and entered into force on 2001, manufacturers and importers of washing machines, TV's, air conditioners, and refrigerators are required to take-back and reuse and/or recycle the discarded products they manufactured. Differentiated recycling rates vary between 50-60% (by weight) among the four product categories and can be fulfilled through product reuse, component reuse, and/or recycling. The domestic electronics assembly industry is aggressively pursuing the removal of lead from the manufacturing process. In 1998, the Japanese government increased levies for recycled leaded equipment. It has established a target of removal of 90% of lead for domestic manufacturing. Amendments to the Law for the Promotion of Effective Utilization of Resources that are scheduled to take effect on July 2006, require that importers will be subject to directives in eight product categories: personal computers (including CRT and LCD displays), unit-type air conditioners, televisions, microwave ovens, clothes dryers, electric refrigerators, electric washing machines and copying machines. Six chemical substances (mercury, cadmium, lead, hexavalent chromium, PBB, and PBDE) will be subject to labeling and reporting requirements.

GAPS FOR IMPLEMENTATION OF 3R

Worldwide, experiences indicate that applying 3R is a lucrative way of tackling waste management issues. The first step in this exercise is an assessment of the technology options available for implementing 3R-based solutions. Proactive policies and relevant legislations emphasizing 3R-based solutions are vital to achieve a higher success rate to form the next step. While recycling is considered as technological ability, reduce and reuse is often considered management or policy oriented. In this context, the following sections present information on the technology and management aspects with a focus on 3R.

TECHNOLOGY GAPS

Japan, despite the economic recession in the last decade has been able to achieve the position of being the second most technologically advanced country. From production to consumption, and waste management, the country has spared no measures to increase its resource efficiency. Recycling and reusing of consumer appliances and electronic waste from domestic sources has been taking place successfully. Continual improvement of technology has been one of the unwritten mission statements of the country.

MANAGEMENT ASPECTS

Japan is a country driven by strong work ethics and management principles. It is no wonder that the various management principles followed by major corporate and manufacturing firms originated from Japan.

White goods recycling
Image source: Nishinihon Kaden Recycle Corporation

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN JAPAN

	Reduce	Status	Reuse	Status	Recycle	Status
Urban Municipal Waste	Resource Conservation Product Lifetime Extension Waste Reduction	● ● ●	Easier Disassembly Remaining Life Assessment	● ●	Thermal Recovery Fuel Recovery Material Recovery Sorting Pulverizing Composting Collection	● ● ○ ○ ○ ○ ●
E-Waste	Resource Conservation Product Lifetime Extension Waste Reduction	● ● ●	Easier Disassembly Remaining Life Assessment	● ●	Material Recovery Sorting Pulverizing Collection	● ● ● ●
Healthcare Waste					Material Recovery Sorting Pulverizing Incineration Collection	○ ○ ○ ● ●

● Formal, Strong
○ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

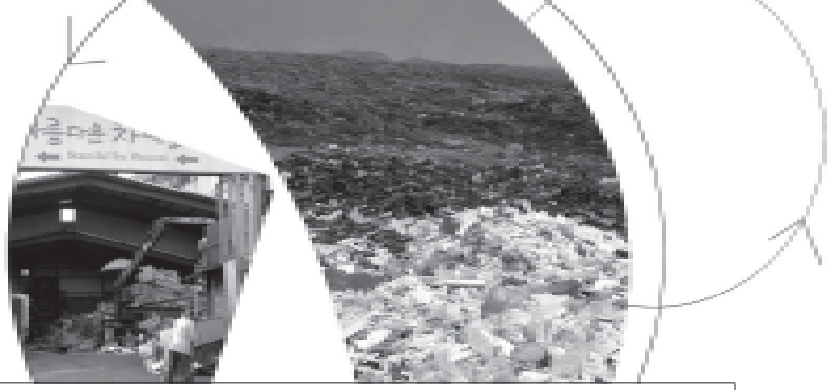
3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	**Framework**	Sound Material Cycle Society	●

	Direct Regulatory	• Waste Reduction Law, 1997
		• Law for Effective Utilization of Resources, 2000
		• Laws for Recycling
		  • Containers and Packaging Recycling Law, 1995
		  • Home Appliance Recycling Laws, 1998,
		  • Construction Material Recycling Law, 2000
		  • Food Recycling Law, 2000
		  • End-of-Life Vehicles Recycling Law, July 2002
		  • Green Purchasing Law, May 2000
			●

	Economic	Establishment of Grants at Local level Financial support to Local Government and Private sector	○
	Voluntary	• Voluntary Action Plan by Industries • Voluntary Eco-labeling	○
	Information	Promotion of Eco Mark Promotion of Eco town Program	○
	Procedural	Environmental Management System Registration ISO 14001	○
Support for 3R-related Activities		• Administrative support by Japan Environmental Association • Financial Support by Central Government	○
Environmental Education		Websites for awareness raising by MoE Information Provision system for green products and databases on good practices regarding green purchasing and environmental labels	○
Science and Technology		Promotion of Research & Technology development Based on "Zero-Emission and Sound Material–Cycle Technology Research" for 3R	●
Reduction of Barriers to International Flow		• Establishment of Asian Network for Prevention of Illegal Transboundary Movement of Hazardous waste • Extended grants–in-aid for the shipping of recycled goods to developing countries	○
International Cooperation		• Cooperative relationships under Basel Convention in Asia • International conferences, workshops and expert meetings on 3R • Supporting Malaysia in organizing Eco-products Exhibition Fair with the participation of more than 19 Asian countries • Participation in Global Ecolabeling Network to study International Harmonization of Ecolabeling standards	●
Cooperation of Stakeholders		• Cooperation between Government officials, private companies, Industries, Office, schools and publics • Based on Zero-Emission and Sound Material–Cycle Technology Research	○
Promotion of Science and Technology for 3R		• Research & technology development for 3R has been promoted	○

● Sufficient ○ Insufficient ☒ Gap

The Korean Waste Management Act classifies solid waste into three categories: household waste, industrial waste and construction debris. As a result of the government's aggressive policy initiatives to reduce solid waste, daily household waste generation nationwide has decreased from 75,000 to 49,000 tons over the last decade...



3.9 Korea

BACKGROUND

With a population of about 50 million in an area of 98,480 km^2, Korea has one of the highest population densities in the world; 500 persons/km^2. The annual rate of population increase in Korea has dropped steadily from more than 3% in the late 1950s to 0.42% in 2006. Urbanization of the country has progressed rapidly since the 1960s, with substantial migration from rural to urban areas; 80% of the population is now classified as urban. Majority of the population live in the southern and western parts of the country.

The Republic of Korea, commonly known as South Korea or just Korea, has a per capita GDP of US$ 24,200, almost equal to some of the smaller economies in the European Union. This success was achieved by a system of close government - business ties, including direct credit, import restrictions, sponsorship of specific industries and a strong labor effort. The government promoted the import of raw materials and technology at the expense of consumer goods and encouraged savings and investment over consumption. With tremendous growth rates on par with some of the western countries, Korea has been one of the top performers in the Asian Continent. However, the country has been experiencing waste management issues owing to its high population density and drastically changing consumption patterns.

PRIORITY AREAS

The Korean Waste Management Act classifies solid waste into three categories; household waste, industrial waste and construction debris. As a result of the government's aggressive policy initiatives to reduce solid waste, daily household waste generation nationwide has decreased from 75,000 to 49,000 tons over the last decade. However, as Korea's economy has rapidly developed, daily industrial waste generation over the last 9 years has increased by 113%, reaching 95,000 tons. In addition, according to the Ministry of Environment, generation of construction debris has increased by 282% over the last five years, reaching 108,000 tons per day.

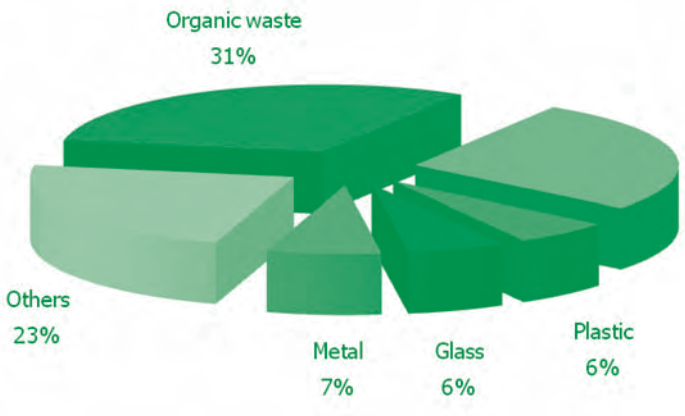
The conscious efforts of the government in reducing household waste have been fruitful. Recycling of electrical and electronic wastes such as home appliances has also yielded positive results. However, industrial waste and construction and demolition waste pose imminent problems to the country and necessitate priority action.

URBAN MUNICIPAL WASTE

South Korea experiences high environmental pressures due to rapid growth in an environment of particularly limited carrying capacity. As a result, the country's waste generation per unit area is one of the highest among Organization for Economic Cooperation and Development (OECD) member countries. Waste generation has steadily increased since 1993. However, South Korea's waste, from both municipal and commercial sources, has substantially decreased after the introduction of the Volume-based Waste Fee System in 1995.

Recycling under the Beautiful Tea museum sign
Image source: Jana's Travel Journal, 2006

The system resulted in savings of about USD 7.7 billion as a consequence of waste reduction of about 61 million tons and increase in recyclable collection of about 28 million tons. Before the implementation of the Volume-based Waste Fee System in 1994, solid waste generation was 1.33 kg/capita/day, which decreased to 1.07 kg/capita/day in 1995, and further decreased to 1.04 kg/capita/day in 2003.



Waste composition in Korea
Source: www.3rkh.net

In March 2002, the country prepared a national framework under the Second Comprehensive National Waste Management Plan 2002-2011 to establish a sustainable and resource circulating socio-economic foundation, thus leading to the consistent promotion of waste reduction policies. A few major policy areas highlighted in this have greater utilization of waste resources, as well as the safe treatment and strengthened management of waste materials. The targets under the plan are to:

- Reduce municipal waste generation by 12%, which is expected to reach about 52,000 tons/day in 2011
- Reduce the amount of waste incinerated or landfilled by 22%; from 28,000 tons/day in 2002 to 21,000 tons/day in 2011
- Increase recycling by 53% by 2011 through efforts including a direct investment of 1.3 trillion Won (1 USD= 930 KRW) for expanding recycling facilities, developing recycling technologies, and fostering the recycling industry
- Reduce industrial waste generation by 8%, while increasing industrial waste recycling to 80%
- Reduce per capita household waste generation from 1.04 kg to 0.94 kg and increasing the household waste recycling rate from 44% to 50% between 2002 and 2008

Findings

In 2003, the Extended Producer Responsibility (EPR) System was introduced. The EPR System which holds producers responsible for meeting recycling targets, is being successfully implemented and currently applies to more than 15 items. Glass bottles, packaging film, fluorescent light bulbs, and electronic products like televisions and computers are covered under the EPR.

As a result of the restrictions on disposable products use in public places since March 1994, the generation of plastic waste material has decreased in many areas. Among the household waste, packaging material comprises the largest proportion at around 37%.

The Ministry of Environment has been pursuing a three-fold policy to tackle the issue. The main objectives of the policy are:

- Regulating packaging materials such as expanded polystyrene i.e., styrofoam, since 1993, and various PVC packaging materials since 2001
- Regulating packaging methods to restrict over-packaging
- Gradually reducing packaging material made from plastics each year

HEALTHCARE WASTE

Generation of waste from the healthcare sector in Korea has rapidly increased over the past decade. According to the MoE, approximately 34,000 tons of regulated healthcare waste was generated from nearly 45,000 healthcare facilities.

National data shows that healthcare waste generation is skewed towards the largest generators- hospitals containing more than 100 beds. Approximately 60% of healthcare waste came from hospitals, which account for only less than 0.7% of all generators. This indicates that such facilities are the largest source of waste when compared to other healthcare facilities. The average amount of waste generated was about 70 tons/hospital in 2002.

The generation rate of waste from general hospitals was found to be 0.48 kg/bed/day with the total number of beds at about 114,000. The amount of waste generated per clinic is significantly lower at 0.2 tons/year, although they represent more than 85% of all generators.

Steam sterilization followed by incineration is the major treatment method for healthcare waste. About 90% of the total waste stream undergoes off-site treatment. The remaining waste, less than 10%, is treated at on-site incinerators or steam sterilization facilities at some general hospitals where incinerators or steam sterilization is available. Only 12 out of the 292 general hospitals treat their own medical waste on-site by incineration, while two general hospitals employ steam sterilization with shredding of their medical wastes. In recent years, many general hospitals have stopped operating their on-site incinerators because of the strict regulations of air pollutant emissions, especially dioxins, and their proximity to the city.

Findings

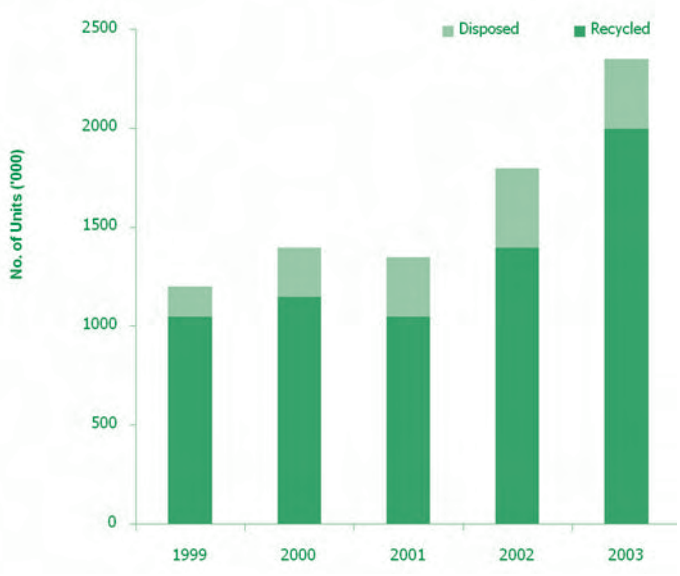
Until 1999, healthcare was regulated by the Medical Law under the Ministry of Health and Welfare. These wastes were often mixed with municipal solid waste and commonly disposed of in municipal landfill sites or improper treatment facilities. Facing the management problems of medical wastes, the Korea National Assembly modified the Waste Management Act in 1999 to better control medical waste from the point of generation to its final destination. The Korean MOE promulgated several regulations for definition, segregation, packaging, tracking, and disposal of medical waste. However, the only available option for managing healthcare waste in South Korea, after 2005, is incineration. Alternatives like separation of waste at source and waste minimization for incineration have not been successful in healthcare facilities.

E-WASTE

The rise in economic growth of Korea in the last two decades increased the volume of e-waste steadily. The rapid growth of the IT industries particularly due to the pivotal role of semiconductor manufacturing is the major driving force for the expansion of the domestic market.

Three recycling centers of capacities close to 900,000 units/year were established and are in full operation to recycle e-wastes, especially refrigerators, washing machines and air conditioners. All waste televisions, in the recent years, are recycled on a commission basis by several private recycling plants. The recycling of waste personal computers and mobile phones is insignificant when compared with the amount of estimated obsolete. Korea is making consistent efforts to improve the recycling rate to the standards indicated in the EU directives.

The sales of electrical home appliances such as televisions, refrigerators, washing machines and air conditioners continued to increase from 5.6 million units in 1990 to 7.8 million units in 2000, accounting for a 40% growth. In 2000– 2004, sales decreased to 5.8 million units, with a reduction of 25%. The reason for this decrease is mainly attributed to the saturation of households with the appliances. The highest rates of obsolescence among the four waste items were obtained during 2000–2005 at 19% and 14% for air conditioners and Televisions respectively. The volume of home appliances collected and treated in Korea is presented in the figure below.



E-Waste Recycling and disposal in Korea
Source: www.3rkh.net

In 2006, the Government of Korea fixed mandatory recycling rates for Televisions (13%), refrigerators (13%), washing machines (23%) etc. Moreover, for mobile phones, audio equipments, copy machines and facsimiles the rate of mandatory recycling was fixed at 15%, 13%, 8% and 8%, respectively.

After the establishment of recycling centers by the electronics industry in 1998 in Korea, treatment and recycling has been continuing for waste such as refrigerators, washing machines and air conditioners. Recycling centers are now being operated at three locations by three major electronic companies, handling a total amount of 880,000 units/year.

Findings

The recycling of waste electronic home appliances has been performed successfully, due to the implementation of the EPR system in 2003. Three main items: refrigerators, washing machines and air conditioners, are being recycled at the recycling centers established by domestic electronic companies, and Televisions are being commissioned to private CRT recyclers.

Korea has enforced the Extended Producer Responsibility (EPR) Law since 2003. The law mandates that manufacturers, distributors and importers of consumer goods such as air-conditioners, televisions and personal computers achieve the official recycling targets or pay financial penalty.

GAPS FOR IMPLEMENTATION OF 3R

TECHNOLOGY GAPS

Korea is one of the Asian countries with tremendous economic growth rates on par with some of the nations in the European Union. The country has been able to achieve its development goals through the use of appropriate technology. The rightful use of appropriate and advanced technology has helped the country be pioneers in semiconductors, wireless telecommunication equipments, motor vehicles, computers, steel, ships and petrochemicals. The upstream manufacturing in Korea adopts advanced technologies. However, an assessment of technologies in downstream waste handling and disposal is essential to implement 3R-based solutions. The table presents an overview of the technologies used for waste management in Korea.

MANAGEMENT ASPECTS

Korea is the second Asian country to be a member of the Organization for Economic Cooperation and Development. The country became an official member in 1996. This clearly indicates that the country has been adopting proactive management and technological measures aimed at developing its economic status. With well-defined policies, enforced legislation and international cooperation initiatives, the country has been progressing at a steady pace.

SOURCES AND QUANTITIES OF HEALTHCARE WASTE IN KOREA

Source of Waste	No. of units	Waste generated (tons/year)	Contribution (%)	Waste generated per Facility (tons/year)
Veterinary institutes	13	23	0.10	1.73
Veterinary hospitals	1912	217	0.60	0.11
Multi-specialty hospitals	919	4523	13.30	4.92
Local public healthcare unit	2684	374	1.10	0.14
Medical research institutes	263	826	2.40	3.14
Clinics	38,238	7663	22.50	0.20
Midwife unit	66	9	0.03	0.13
General hospitals	292	19,990	58.80	68.46
Blood banks	17	353	1.00	20.78
Others (Crematory)	74	3	0.01	0.04
TOTAL	**44,478**	**33,981**	**100.0**	

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN KOREA

	Reduce	Status	Reuse	Status	Recycle	Status
Urban Municipal Waste	Resource Conservation Product Lifetime Extension Waste Reduction	● ● ●	Easier Disassembly Remaining Life Assessment	● ◎	Thermal Recovery Fuel Recovery Material Recovery Sorting Pulverizing Composting Incineration Collection	● ● ◎ ☒ ☒ ☒ ● ●
E-Waste	Resource Conservation Product Lifetime Extension Waste Reduction	● ● ●	Easier Disassembly Remaining Life Assessment	● ◎	Material Recovery Sorting Pulverizing Collection	● ● ⊙ ●
Healthcare Waste					Material Recovery Sorting Pulverizing Incineration Collection	☒ ☒ ☒ ● ●

● Formal, Strong
◎ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	Sound Material-Cycle Economy Sustainable Development (efficient use of Natural resources)	○
	Direct Regulatory	Waste Management Act • Volume Based Waste Fee System • Reduction of Industrial Waste • Act for Resource Recycling of Electrical/Electronic Products and Automobiles Saving and recycling of resources Act • Packaging waste reduction • Restriction of disposable goods Extended Producer Responsibility (EPR) system Construction Waste Recycling Act Green Product Purchase Act Comprehensive plan for the Resourcification of Food Waste	●
	Economic	Financial Support to enforce recycling infrastructure Incentive to reduce waste generation Environmental Industry	○
	Voluntary	Voluntary Agreement implemented between government and private sector Voluntary Agreement Signed between MoE and 29 companies running fast-food coffee business	○
	Information	• Guidelines for industrial waste reduction • Promotion of product design improving material & structure of the products • Publicly notify list of green procurement products certified as Recycled goods, Environmental Labeling and Korean Standard • NGO campaign Information through education service and promotional activities	○
	Procedural	• Korean Standard • Environmental Management System Registration to ISO14000	○
Support for 3R-related Activities		Ministry of Housing for Domestic waste Ministry of Natural Resources & Environment for Hazardous waste	○
Environmental Education		Awareness program campaign through electronic & mass media	☒
Science and Technology		National Strategy for Enhancement of R & D is Essential Development of Institutions for Waste Minimization	○
Reduction of Barriers to International Flow		Basel Convention on the Transboundary Movement of Hazardous Waste, December 1996	○
International Cooperation		NGO's from Asian Countries • China to inspect E-waste recycling practices • Japanese NGOs working on waste issues Information sharing and policy discussion • Greenpeace China • International Basel Action Network • Envirosia: North East Asia	○
Cooperation of Stakeholders		Cooperation of Government, Industries & private sectors	☒
Promotion of Science and Technology for 3R		Development of technology for • Waste management • Saving and recycling of Resources • Reduce Industrial waste generation • Construction waste recycling • Product Design for 3R	○

● Sufficient ○ Insufficient ☒ Gap

The rightful use of appropriate and advanced technology has helped the country be pioneers in semiconductors, wireless telecommunication equipments, motor vehicles, computers, steel, ships and petrochemicals. The upstream manufacturing in Korea adopts advanced technologies. However, an assessment of technologies in downstream waste handling and disposal is essential to implement 3R-based solutions...

The Laos government has been taking all possible steps in the management of urban municipal waste. However, the management of healthcare waste in the country is the primary issue that has not been adequately addressed. Considering the direct and indirect threats of ill-disposed healthcare waste, it is essential to design, fund and implement appropriate systems for its management...

3.10 Laos

BACKGROUND

The Lao People's Democratic Republic, shortly Laos, is a landlocked country in Southeast Asia. It has common borders with China, Cambodia, Thailand and Vietnam. The total land area of the country is 236,800 km^2, the major part being mountains and forests. The country is divided into three geographical areas: the Northern, the Central, and the Southern areas. Laos has a population of about 6.5 million growing at a rate of 2.37% under 47 different ethnic groups. The population density is around 25/ km^2.

The long-term national development goal of Laos is to achieve sustained economic growth and social development while safeguarding the country's social, cultural, economic and political identity. In response to this, the government is committed to promote the Laos Integrated Waste Management (IWM). This includes training of trainers approach and commitment by the National Science Council and Laos Union of Science and Engineering Associations and all relevant stakeholders in building a knowledge base. The vision of Laos' IWM is on the continuous support of the local community and all relevant institutions and partners.

PRIORITY AREAS

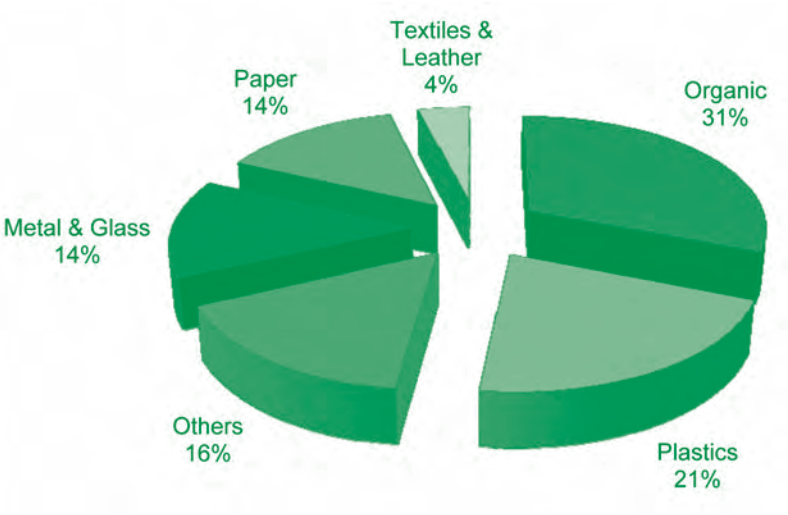
With a per capita GDP of US$ 402, Laos is one of the poorest countries in the East Asia and Pacific Region. The country's human development ranking is 143rd among 175 countries. With this level of poverty, the country's natural resource is of critical importance to poverty alleviation and growth. However, natural resource degradation, combined with inadequate provision of environmental services is disproportionately affecting the poor in Laos.

As in any developing country, waste management is an issue to be addressed holistically. The case in Laos is slightly different in that the government has been taking all possible steps in the management of urban municipal waste. However, the management of healthcare waste in the country is the primary issue that has not been adequately addressed. Considering the direct and indirect threats of ill-disposed healthcare waste, it is essential to design, fund and implement appropriate systems for its management.

URBAN MUNICIPAL WASTE

The generation of solid waste in Lao PDR is already on the rise, and has started degrading the quality of surface and groundwater. Expanding urban population, poor waste collection systems and largely inadequate disposal facilities are the reasons for the compounding solid waste problem.

The annual waste generation in 2004 was 270,000 tons. Domestic waste accounts for the bulk of materials generated. The average urban waste production in Laos is 0.75 kg/cap/day



Composition of Generated Waste in Vientiane

per day. Vientiane and the four secondary towns account for 0.8–1.4 kg/cap/day. Solid waste in Laos comprises mainly of organic material, plastic, paper, and glass, cans and other metals. Hazardous and toxic wastes such as batteries, old paint cans, aerosols and other refuse are also mixed with these wastes. The comparatively low content of organic material in municipal solid waste is mainly due to the fact that a large proportion of food waste is recycled as animal feed even in urban areas.

TOWN	Per capita waste production
Vientiane City	0.8 kg
Luangprabang	1.0 kg
Thakhek	0.8 kg
Savannakhet	1.0 kg
Pakse	1.4 kg

According to a recent survey in 57 urban areas, only Vientiane City and the four secondary towns of Luang Prabang, Thakhek, Savannakhet and Pakse use controlled open dumps for solid waste disposal. However, the disposal areas are small, and have no leachate collection and monitoring wells. In many other places, uncontrolled open dumping and burning are commonly practiced. Hazardous and infectious wastes are often disposed together with municipal waste.

Despite the existence of controlled dumpsites in Vientiane and the four secondary towns, collection services are limited only to accessible areas and profitable target groups such as markets and high-income households. The average collection rate of about 45% is recorded in the urban households of the five larger urban areas. Collection rates reach more than 50 percent only in Luang Prabang. In smaller towns, solid waste collection is often limited to commercial establishments in the town centre and the market place.

About 70% of municipal solid waste consists of plastic, paper, glass, cans and metals, which have the potential to be recycled commercially, and reused in various manufacturing and industrial activities. However, the current scale of recycling in Lao PDR is still very modest.

Findings

Hazardous and toxic wastes such as batteries, old paint cans, aerosols and other refuse are mixed with solid waste and as such no separation of waste is practiced. Of the total waste discarded in Laos, 50 % is recyclable.

Solid waste collection is only in Vientiane and other major towns in the five big provinces. In Vientiane, a combination of state and private firms take up the task of waste collection. About 60% of the total waste generated is collected. The Vientiane Municipality sets the collection frequency as well as the solid waste charges per household.

Key issues of solid waste management in the capital city include lack of awareness on the proper disposal of solid waste, excess of waste collection to the dumping sites, which result to bad odor, poor separation of waste into different containers and the generally dirty urban city and environment.

A combination of state and private companies, assigned different sections of the four urban districts, take up the task of waste collection. The Municipality Government dictates collection frequency and payments by households. Vehicles in use are a mix of new Japanese trucks, reconditioned French waste collection vehicles and locally purchased vehicles.

In the national level, Science, Technology and Environment Agency is responsible for waste management in Laos, whereas, urban waste management is under the jurisdiction of the Ministry of Communication, Transport, Port and Construction.

Waste management in Laos is shared by national and provincial government, although primarily implemented through local authorities. Progress in waste management has depended on donor support including that of NGO and private sector participation.

The Lao Garbage Society (LGS) founded in 1994 offers residential and commercial pickup and transportation to the dumpsite. In 1997, the Japanese International Corporation Agency (JICA) founded the Urban Cleansing Service (UCS). JICA donated USD 2.7 million in constructing a building for UCS, upgrading the dumpsite, purchasing vehicles and large metal solid waste bins. UCS currently contributes to 90% of the solid waste collection in Vientiane and LGS contributes to the remaining 10%. A local NGO, the Participatory Development Training Centre, setup a company that buys recyclable materials and ships them to Thailand. This has led to the promotion of recyclable banks buying recyclable materials from individuals and members of the informal sectors such as the rag pickers and informal collectors.

Similarly, Waste-Econ Program conducted a research funded by CIDA from 2000-2005 involving partnerships with a number of government institutions, universities and NGOs in Vietnam, Cambodia and Laos. The program aimed to explore methods for recycling, exchanging and reducing in ways that will be beneficial to the economies of the partner countries, to people working in the waste sector and to the environment as a whole. In Laos, the University of Toronto has partnered with the National Science Council at the Prime Minister's Office in Vientiane. Pilot projects such as feasibility studies of composting organic wastes from markets in Vientiane have been carried-out.

In 2001, community based recycling was initiated in three villages and three schools in the central districts of Vientiane. The objective of the project was to educate people to separate their waste in order to reduce the amount of material that goes to the landfill. The project was funded by the Royal Netherlands Embassy in Bangkok and UNDP.

HEALTHCARE WASTE

In Laos, the amount of healthcare waste is increasing with the improvement in health-care activities since 1990 when the country opened its doors to people from other countries and various health organizations started their activities. It has been observed that the amount of sources of potential healthcare wastes, such as equipment (for laboratory tests, medical treatments, and immunization), medicines and vaccines has been increasing beyond the capacity for its disposal by the existing management systems, especially in rural areas (Kuroiwa et al. 2004). In response to these concerns, incinerators were installed in all 18 municipality/provinces due to the efforts of the WHO and UNICEF. In some rural areas, untreated healthcare waste including hazardous infectious waste is dumped in uncontrolled sites (e.g., the backyards of healthcare facilities) that are accessible to the general public. Healthcare waste segregation has been implemented since 1999 through a healthy city program under the auspices of the Ministry of Health, however, the program is not yet widespread (Kuroiwa et al. 2004).

A study by Phengxay et al (2005) discusses deeply the current situation of healthcare waste management in Lao PDR. The study indicates that the MOH allocated a budget for healthcare waste management only to the national hospital level. Three provincial hospitals were supported by a NGO and the others, particularly at health centre level did not have any fund for healthcare waste activities.

The study also indicates that sharp waste segregation was done at all healthcare facilities. With regard to infectious waste segregation, color-coded bags were used only at the national hospital and in some provincial hospitals. Labels were used at some provincial hospitals. For final disposal of healthcare waste, Vientiane Municipality and four

provinces adopted sanitary landfill, and 11 provinces depended on dumping and/or a local incinerator. Phengxay et al (2005) indicated that only the provincial hospital in Vientiane Municipality had a healthcare waste manual produced by a Japanese volunteer.

The same study indicates that in Vientiane Municipality, the average amounts of healthcare waste was 0.84 kg/bed per day at the national hospital; 1.08 kg/bed per day at the provincial hospital; 0.47 kg/bed per day at the district hospital; and 0.08 kg/bed per day at the health centre.

In Bolikhamxay: 0.56 kg/bed per day at the provincial hospital; 0.33 kg/bed per day at the district hospital; 0.24 kg/bed per day at the health centre. The proportion of healthcare waste with total average in two study sites by kg/bed per day was 23% (17% at the inpatient department, 58% at the outpatient department). Due to the wide-ranging bed occupancy rate, it was found that the inpatient departments generated a much greater amount of healthcare waste (kg/patient per day) than the outpatient departments.

The healthcare waste in the inpatient departments in Vientiane Municipality and Bolikhamxay were 1.46 kg/ inpatient per day and 0.57 kg/inpatient per day, respectively. The proportion of healthcare waste for an inpatient was higher at the primary health-care level (health centre): 42% at a health centre compared with 17% at the national hospital in Vientiane Municipality. In Bolikhamxay, it was 45% at a health centre and 19% at the provincial hospital.

Findings

A study conducted at two places in Laos, Vientiane Municipality and Bolihamxay province, focusing on the amount of healthcare waste, its segregation and the influencing factors, particularly segregation procedures revealed that healthcare waste was poorly segregated.

Higher proportions of healthcare waste were observed from the inpatient department at the primary healthcare level. Healthcare waste management at primary healthcare facilities needs more attention. Segregation of sharp waste has to be enforced at all healthcare facilities. For infectious waste segregation and usage of color-coded bags is practiced only at the national hospital and in some provincial hospitals.

As for the disposal of healthcare waste is concerned, the municipality of Vientiane and four provinces adopted sanitary landfill, and 11 provinces depend on open dumping and (or) a local incinerator.

There is a need to establish a national policy on healthcare waste management in Lao to prevent hazardous healthcare waste causing pollution and harm to human health. In particular, the current levels of healthcare waste management at primary healthcare facilities needs to be given much more attention and be better understood. Furthermore, additional details of the final disposal situation should be investigated and provision of collection services to the appropriate dumping sites, incinerators, or disinfecting methods are needed to protect the health of the population and the environment.

E-WASTE

Most of e-wastes in Laos come from household appliances, office, information and communication equipment, entertainment and consumer electronics, lighting equipment, electric and electronic tools.

Currently, no data is available on the amount or volume of e-waste in the country but the current situation of e-waste in Laos is increasing daily and definitely would be a problem in the near future for most of Laos's residents.

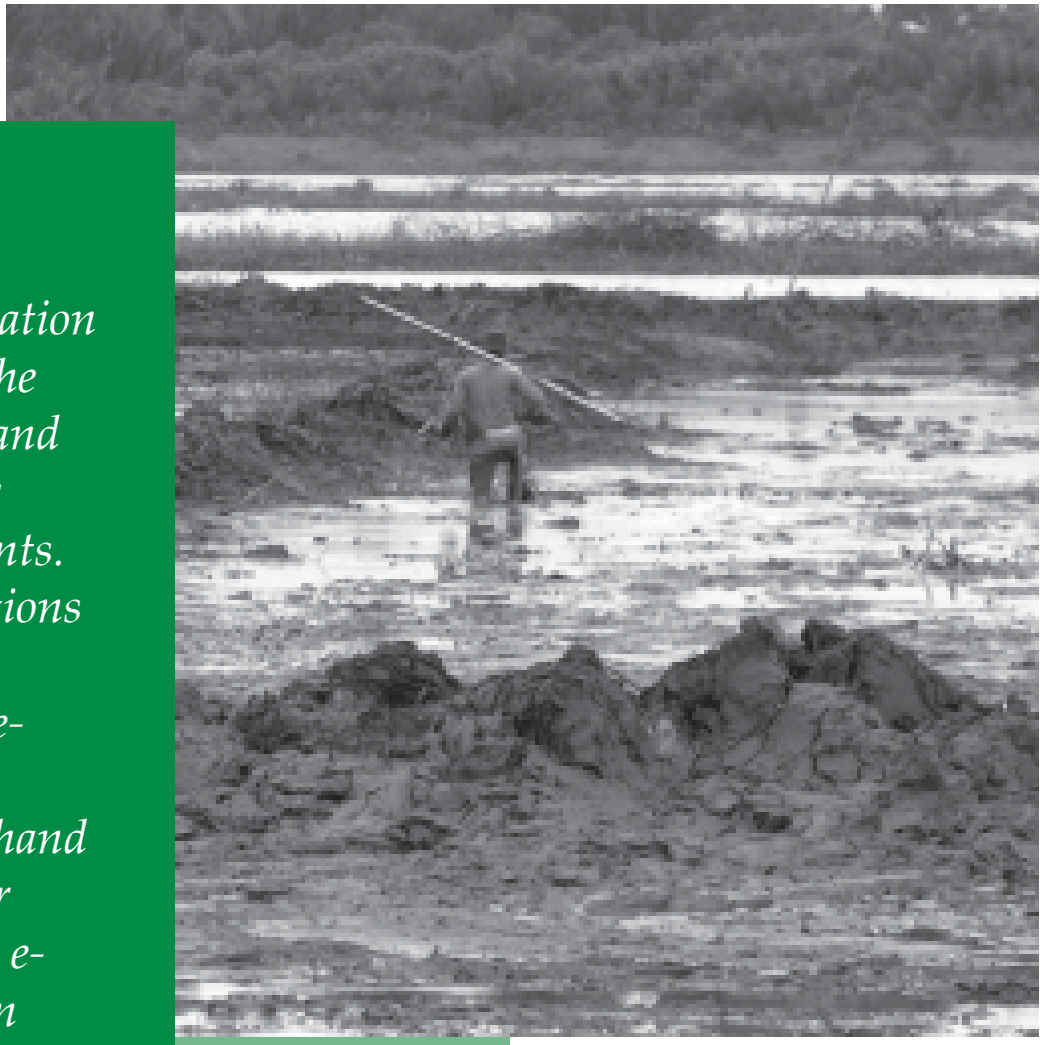
Findings

In Lao PDR, there is no specific legislation or regulation for the control on the import of second hand electrical and other electronic equipments. Most of the regulations on imports do not include the risk of e-waste entering the country as second hand equipment. Further issues arising from e-waste have not been addressed in the Environmental Protection Law of the government of Laos.

Efforts were made by the Government of Lao PDR to develop a number of legislations to deal with hazardous wastes and protect the country from the import of banned chemicals and hazardous wastes. An example of such a move is the creation of the Environmental Protection Law (EPL) in April 1999. In Article 23 of EPL, it was stated that "it is forbidden to import, transport and move all kinds of hazardous waste through land, water and sky border of the Lao PDR".

Other strategies and legal framework adapted by the Lao Government was the formulation of "The Hazardous Chemical Strategy to the Year 2020 and Action Plan for the Year 2006-2010" as starting point in addressing the environmental problems related to the import, production, usage and disposal of hazardous chemicals in Lao PDR. The country has also been a signatory to a number of international conventions regional agreements such as Montreal Protocol on Substances that Deplete the Ozone Layer (1998), the Stockholm Convention on Persistent Organic Pollutants (2006) and Basel and Rotterdam Convention.

The only related regulation is the decree on the control, import and export of electrical equipment in the county. Moreover, the Lao Government prohibits the import of products, materials, appliances or vehicle designed to use the controlled substances from 2006 and the import of ODS will be prohibited from 2008.



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TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN LAOS

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	☒
	Fuel Recovery	☒
	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Composting	○
	Incineration	●
	Collection	●
E-Waste	Material Recovery	☒
	Sorting	☒
	Pulverizing	☒
	Collection	☒
Healthcare Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Incineration	●
	Collection	☒

● Formal, Strong
● Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	The Environment Protection Law of Lao PDR 1998	○
	Direct Regulatory	• Decree on the Management of Solid Waste and the Cleaning of Public and Residential Areas • Regulation on the Monitoring and Control of Waste Discharge (No.1122/STENO) 1998 • Guidelines for Hospital Waste Management (1997) • Industrial Waste Discharge Regulation (No.180/MIH) 1994	○
	Economic	National Environmental Action Plan 2006-2010 National Environmental Strategy-up to 2020	○
	Voluntary	Lack of Voluntary Initiatives by Government, Industry and communities	☒
	Information	Lack of specific Information Instruments	○
	Procedural	Lack of specific environmental quality surveillance instruments	☒
Support for 3R-related Activities		UNCRD – Sustainable Production and Consumption	☒
Environmental Education		National Strategy on Environmental Education and Action Plan for 2006- 2010	○
Science and Technology		Promotion of clean technology Waste minimization in small scale and large scale industries	☒
Reduction of Barriers to International Flow		Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal (1989) 5 May 1992.	○
International Cooperation		SIDA - Strengthening Environment Management project ADB - Environmental and Social Program LoanWorld Bank - Lao Environment and Social Project Wildlife Conservation Society – "Curriculum Enrichment Program in Environmental and Life Sciences" and "Health, Environmental and Clean Water Supply Program"	○
Cooperation of Stakeholders		Lack of cooperation among the stakeholders within the country	○
Promotion of Science and Technology for 3R		Under implementation level	☒

● Sufficient ○ Insufficient ☒ Gap

In Kuala Lumpur, the city council started looking at an integrated approach to solid waste management as an alternative to the old concept of just dumping all the waste generated. This new outlook by the city council has brought about activities such as waste recycling and recovery followed by incinerating the waste to recover the energy, with only the final inert material being considered for land filling...

3.11 Malaysia

BACKGROUND

With about 330,000 km^2 and a population of over 24 million, Malaysia has a per capita GDP of USD 12,700. Industry and the services sector contribute a whooping 48% and 43%, respectively. Agriculture contributes a meager 9% to the GDP. This demonstrates the lifestyle of the population in the country. As in the case of any developing country, Malaysia is also facing threats of urbanization and industrialization. Increasing industrial activity and growth in population is always reflected in waste generation concerns. Malaysia is no exception. With limited natural resources and land availability, Malaysia is at the crossroads of sustainability in waste management and disposal.

PRIORITY AREAS

Since mid 1980s, solid waste generated in urban areas of Malaysia has been increasing yearly due to rapid urbanization and diversified lifestyles. As a result, problems with increasing waste management costs and securing landfill sites have arisen in the country. The national average waste generation is found to be ranging between 0.5–0.8 kg/ person/day, but in the cities it has escalated to 1.7 kg/person/day. On an average, about 2,500 tons of municipal solid waste is collected every day in the city of Kuala Lumpur alone and dumped at the Taman Beringin dumpsite. Since the lifespan of this dumpsite has already expired, the city council built a transfer station at the Taman Beringin dumpsite as a temporary solution, and put into operation in 2001, to facilitate the transfer of the waste to a new site.

Evidently, solid waste management in the urban centers is a priority issue requiring immediate attention. Considering the need, the city council started looking at an integrated approach on solid waste management as an alternative to the old concept of just dumping all generated waste. This new outlook by the city council has brought about activities such as waste recycling and recovery followed by incinerating the waste to recover the energy, with only the final inert material being considered for land filling. This is aimed at reducing the burden on landfills and also open opportunities for new technologies in treating the urban municipal waste.

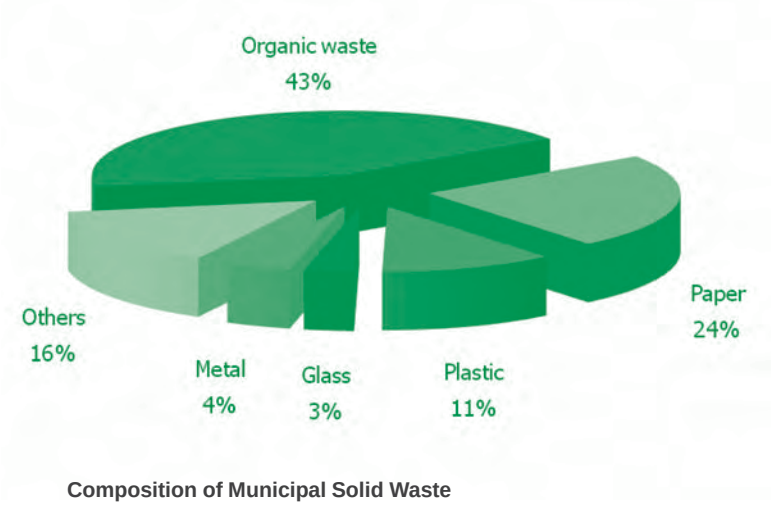
URBAN MUNICIPAL WASTE

Solid waste generation increased from 16,200 tons/day in 2001 to 19,100 tons/day in 2005 in Peninsular Malaysia. About 76% of waste generated is collected and 1-2% of waste is recycled (from the collected waste) while the remaining is taken to the disposal sites. There are about 175 disposal sites operating as open dumps in Malaysia. In Kuala Lumpur, only about 5% of waste collected is reused and recycled. The states of Selangor and the Federal Territory, the highly urbanized and industrialized areas, contribute about 36% of MSW generated in Malaysia.

Currently, most waste is disposed in landfills, but due to rapid development and lack of space for new landfills, big cities in Malaysia have been switching to incineration. The main components of the waste were found to be food, paper and plastic, which make up almost 80% of the waste by weight.

The figure below presents the composition of MSW in Malaysia. The average moisture content of the MSW was about 55%, making incineration a challenging task. Calorific value of MSW varies between 1,500 and 2,600 kcal/kg. However, the energy potential from an incineration plant consuming about 1,500 tons of waste/day with an average calorific value of 2200 kcal/kg is assessed to be at 640 kw/day. Calorific value of the MSW has allowed the Government of Malaysia to promote thermal treatment to partly solve both waste management problems currently being faced by major cities and to recover energy through incineration.

In Malaysia, local authorities spend up to 60% of annual budget for waste management (UNEP, 2007). Despite efforts to promote 3R through a nation wide campaign, the amount of waste recycled is less than 5%. The Government of Malaysia (GoM) has privatized SWM and has adopted an integrated waste management system in its efforts to minimize environmental degradation. Since 1997, two companies identified by GoM, Alam Flora Sdn Bhd (AFSB) and Southern Waste Management Sdn Bhd (SWMSB) have been engaged in interim management contracts with the local



Composition of Municipal Solid Waste
Source: www.3rkh.net

Urban refuse in Malaysia
Image source: Asia-link -TETRAWAMA Project 2006

authorities within their respective concession areas. One private waste concessionaire has undertaken a pilot project to compost green waste in its landfill. The concessionaire has targeted to compost 8% of the collected waste. Very few manufacturers and companies are doing much for recycling.

As a significant proportion of municipal solid waste in Malaysia comprises of plastic carry bags, a pilot project for Reducing Plastic Carrier Bag Waste has been put forward. The project has been under experimentation since 2001. A strategic plan for solid waste management, composting, RDF, recycling of tyres and plastic are under research. A collaborative project "Structuring and Institutionalizing Solid Waste Management in Penang" was launched in 2006 between the Penang State Government, UNDP and local authorities in Penang, the Majlis Perbandaran Pulau Pinang and Majlis Perbandaran Seberang Prai.

Findings

Only about 2-5% of waste in Malaysia is recycled. A large amount of solid waste is straining existing landfill sites, and the majority of disposal sites are merely opens dumps. Malaysia's commitment to private sector involvement in environmental management and infrastructure development has led to many significant environmental programs

nationwide. Malaysia has plans to set-up more incinerators to deal with mounting piles of waste in landfills. Strategic plans for solid waste management, composting, RDF, recycling of tyres and plastic are under research.

The government relaunched its recycling campaign in 2000 targeting 22% of waste to be recycled by 2020. Composting is still being studied but not as a priority activity now. The Malaysian government's plans to build solid waste incinerators are disincentives for communities to practice waste reduction. Without relevant legislations and proper enforcement, the country is facing difficulties in implementing waste reduction programs.

In order to formulate Action Plans for the Federal and Local Governments and Guidelines to Promote Waste Minimization in line with the National Strategic Plan for Solid Waste Management in Malaysia, a joint study was launched by the Government of Malaysia and the Government of Japan. The Ministry of Housing and Local Government has also taken the lead in promoting and establishing recycling systems. However, despite the government's efforts data shows that the rate of recycling of solid waste remains at about 2 to 5% per year.

HEALTHCARE WASTE

As of 2003, Malaysia had 118 government hospitals and healthcare centers (28,500 beds), seven special medical institutions (6,300 beds) and 220 private hospitals (9,000 beds). On an average, a waste generation rate of 1.9 kg/bed/day has been reported.

Malaysia's healthcare waste management was privatized in 1995. A number of regional and on-site medical waste incinerators were built. Currently there are five regional medical waste incinerators with different capacities of 20 to 500 kg/hr. Three more incinerators with capacities of 200 kg/hr have been planned and are yet to be built. There are seven small on-site healthcare waste incinerators with 20kg/hr and 50kg/hr capacities.

Following the Healthcare Waste Management Plan 2005 developed by the Ministry of Health, Peninsular Malaysia was divided into three healthcare waste management zones. Each zone was contracted a concession to a private company for 15 years. Within the concession zone, the private contractor was required to provide bins and bags for primary and secondary collection, storage, external transport, and a central localized incinerator for special healthcare waste generated at the hospitals.

Findings

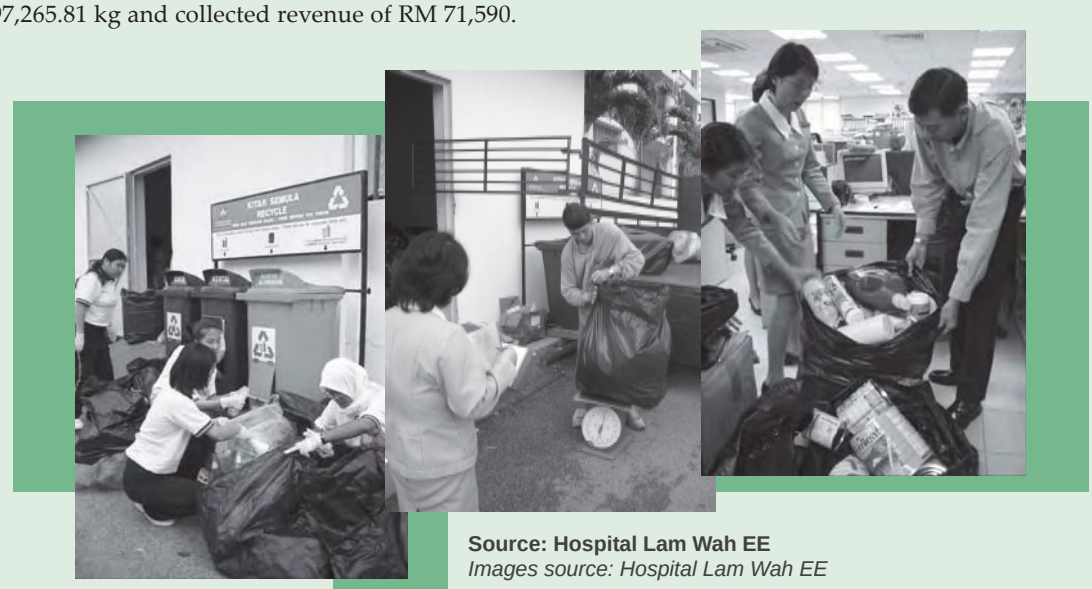
Healthcare waste management in Malaysia was privatized with incineration facilities adhering to the standards for emissions to those of the European Union. Lack of published and reliable information on recycling activities and other green practices in the hospitals has been a major issue hindering decision-making at the country level. It could be observed that incineration is the preferred mode of disposing healthcare wastes in the country with an uncertainty on the efficiency of the systems though. Hospital Lam Wah EE has set an example for the rest health sectors within the country in recycling its waste.

Hospital Lam Wah EE Staff attending its waste
Image source: Hospital Lam Wah EE

Hospital Lam Wah EE's Recycling Project (Malaysia)

In Hospital Lam Wah EE, the generated wastes are segregated at source and bagged separately following specific guidelines outlined in the hospital's Infection Control Manual. Clinical wastes are both autoclaved and incinerated. General wastes are collected by the local authority and taken to the designated dumpsite when recyclable wastes are recycled and the fund received from these recyclable materials are used to help hospital staff in need or used to respond to emergency situations. The Recycling Project Committee was set-up on 28 June 2002 with 19 members. They sort out the recyclable items, categorize them and weigh them before selling.

Old Newspapers, Books/Magazines/Loose, Papers, Cardboards, Clear and colored Plastic Bottles, Drip Bottles, Glass Bottles, Tins/Cans/Cooking Oil Bottles, Aluminum Cans, Plastic Bags, Old Clothes (wearable) and Old Car Batteries are collected and sorted. Some of these recyclable materials are also brought in by staff members from their houses. They also initiated lots of awareness campaigns and promotions to enhance this recycling activity. Up till the end of June 2006, the hospital managed to recycle a total of 297,265.81 kg and collected revenue of RM 71,590.



Source: Hospital Lam Wah EE
Images source: Hospital Lam Wah EE

Waste recycled by Hospital Lam Wah EE

Date	Total Weight	Sales
July-Dec 2002	21,017.90 kg	RM3,653.19
Jan-Dec 2003	56,929.20 kg	RM13,503.18
Jan-Dec 2004	82,583.90 kg	RM19,133.12
Jan-Dec 2005	84,184.16 kg	RM22,155.70
Jan-Jun 2006	52,550.65 kg	RM13,144.20
Total	**297,265.81 kg**	**RM71,589.39**

** 1.00 RM=0.294 USD*

E-WASTE

Currently, there are three different e-waste management practices in Malaysia:

- Informal e-waste management by local e-waste trade
- Landfilling by four private companies Alam Flora Sdn Bhd, Northern Wastes Industries Sdn Bhd, Southern Waste Management Sdn Bhd and Eastern Waste Management Sdn Bhd
- Special recycling programs like National Mobile Phone Recycling Program, Dell Malaysia PC Recycling Program in Penang and PIKOM-Alam Flora PC recycling program in Kuala Lumpur

There are about 86 licensed contractors working for partial recovery and few for full recovery for scheduled e-waste (SW110).

An integrated hazardous waste treatment facility was built at Bukit Nanas in 1992 by the Danish-Malaysian group Kualiti Alam Sdn. Bhd. The plant has five major facilities for treatment

and disposal of hazardous waste; incineration plant, physical/chemical treatment plant, secured landfill, and leachate treatment plant.

Malaysia ratified the Basel Convention in 1993, and under Section 34B (amended in 1996) of the Environmental Quality Act of 1974. According to the Act, the receipt or shipment of any specified wastes into or out of territorial waters without prior written approval from the Director General of Department of Environment is prohibited. The specified wastes subject to these restrictions are set forth in the Environmental Quality (Scheduled Wastes) Regulations of 1989. Businesses involved in collection and recycling of scheduled wastes are required to obtain a license from the Department of Environment. About 57 companies were identified and licensed for such businesses as of March 2005. The Government of Malaysia has also submitted a notification to the Basel Convention Secretariat with the changes to their national definition of hazardous wastes, other than those listed in the Basel Convention. Additional other hazardous wastes controlled for the purpose of Transboundary Movement in Malaysia are slag from copper processing, oil tanker sludge, granulated slag and spent industrial catalysts.

Findings

Malaysia has specific restrictions on Transboundary Movement of waste. Currently there are three different ways of e-waste management in Malaysia. They are through local trade of e-waste, normal ways of land filling done by private companies and special ways through recycling programs. Though Malaysia has been attempting to address the issues arising on e-waste a general lack of information prevails.

It is also evident that the recycling business in Malaysia is predominantly done in the informal sector with no specific policies and enforcing legislations in place. Informal recyclers, recycling facilities and traders of e-waste owe a major share of the country's recycling arena. Considering the threats and lack of legislation on e-waste, awareness/education campaigns for public and industry are being continuously conducted by the Government. With neighboring countries competing for waste recycling, Malaysia is not well positioned in the business thus providing relief to the country in terms of related issues.

GAPS FOR IMPLEMENTATION OF 3R

Worldwide, experiences indicate that applying 3R is a lucrative way of tackling waste management issues. The first step in this exercise is an assessment of the technology options available for implementing 3R-based solutions. Proactive policies and relevant legislations emphasizing 3R-based solutions are vital to achieve a higher success rate to form the next step. While recycling is considered as technological ability, reduce and reuse is often considered management or policy oriented. In this context, the following sections present information on the technology and management aspects with a focus on 3R.

TECHNOLOGY GAPS

Malaysia's solid waste management needs are huge considering the existing capacity and the persistent growth of urban areas and industrial development. Without the necessary measures to establish effective handling, treatment, and disposal systems, the growing quantities of waste can have various impacts, from increased health risks to environmental degradation. Table presents an overview of the various technologies applicable for 3R and their status in Malaysia.

MANAGEMENT ASPECTS

On the verge of rapid growth, Malaysia has been facing various issues like any other developing country and has been constantly struggling to improve the living conditions in the country. In this endeavor, Malaysia has kept itself open to the introduction of new technologies and management practices aimed towards development and growth. It is essential that the management, legislative and policy aspects of waste management with emphasis on 3R be studied to understand the situation better. The table presents an overview of the management aspects in Malaysia with reference to 3R.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN MALAYSIA

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	●
	Fuel Recovery	●
	Material Recovery	◘
	Sorting	●
	Pulverizing	☒
	Composting	☒
	Incineration	●
	Collection	◘
E-Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	☒
	Collection	⊙
Healthcare Waste	Material Recovery	☒
	Sorting	●
	Pulverizing	☒
	Incineration	●
	Collection	●

● Formal, Strong
◘ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	**Framework**	National Strategic Plan for Solid waste management 2005 National Recycling Program, 2000	○
	Direct Regulatory	• Recycling Among Population • Cost Recovery Plan • Environmental Quality Regulations for Hazardous waste	○
	Economic	Lack of economic instruments or information thereof	☒
	Voluntary	• Federal Government Deals with hazardous materials • Local Government dealing with Municipal waste	○
	Information	• Awareness Program campaign through electronic and mass media • National Recycling day for Malaysia • Participation of Stakeholders, NGOs, Private sectors and Local Community	○
	Procedural	Lack of systems for environmental quality surveillance	☒
Support for 3R-related Activities		• Ministry of Housing for Domestic waste • Ministry of Natural Resources & Environment for Hazardous waste	○
Environmental Education		Awareness program campaign through electronic & mass media	☒
Science and Technology		Lack of Institutions for Waste Minimization and 3R	☒

Reduction of Barriers to International Flow		• Malaysia is a party to the Basel Convention on Transboundary Movement of Hazardous Waste and the BAN Amendment, 1993
		• Agreement on Transboundary Movement of Hazardous Wastes from Malaysia to the United States
		• Orders formulated
		  • Customs (Prohibition of Export) Order
		  • Customs (Prohibition of Import) Order
			○

International Cooperation		• For information sharing, Training, Public Awareness • Green Aid Plan, Japan	○
Cooperation of Stakeholders		Participation of major stakeholders NGOs, private sector & local community in 3R activities	○
Promotion of Science and Technology for 3R		• Promotion of science & technology through the National Waste Minimization Study & Recycling facilities for hazardous waste	○

● Sufficient ○ Insufficient ☒ Gap

In the Philippines, more than 50% of the paper industry's fiber requirements are met by waste paper. Considering the volume and potential, recycling of paper and plastics assumes top priority in the country. However, hazardous materials such as Used Lead Acid Batteries need to be appropriately taken care of by virtue of their threats to the environment and the country...

3.12 Philippines

BACKGROUND

Republic of Philippines is an island nation located in Southeast Asia, with Manila as its capital. It comprises over 7,000 islands with a total land area of approximately 300,000 km^2. The country has a population of about 90 million contributing to an average GDP growth rate of about 5% between 2002 and 2006.

An appreciable growth of GDP, as in any developing country, is accompanied by a stress on the natural resources and environment. The government has various measures to protect the country from man-made and natural disasters. The high population and ever-changing consumer preferences have led to an increase in the waste generation rate and quantity. Waste Management has always been an issue of debate in landlocked countries. In the Philippines, the situation becomes worse with its discrete islets; transporting the waste to a central facility takes the major portion of the handling cost. In such situations, managing the waste at the source by applying principles of 3R looks to be an attractive option.

PRIORITY AREAS

In Metro Manila, paper waste tops the list of recyclable materials and constitutes about 20% of the waste volume or about 1,100 tons per day. In the Philippines, more than 50% of the paper industry's fiber requirements are met by waste paper. The recovery of waste paper in the country is relatively low compared to other Southeast Asian countries except Indonesia. Thailand has a waste paper recovery rate of 33%, Singapore 31%, Malaysia 28% and Indonesia 14%. The reported world average was 31%. The Philippine Pulp and Paper Association (PULPAPEL) estimate a recovery rate of around 15%.

Approximately 2.3 million metric tons of hazardous waste, especially Used Lead Acid Batteries, is generated every year. By 2004, 3,015 hazardous waste generators were registered with the Environmental Management Bureau. Oil, immobilized waste, containers, and plating waste make up more than half (55%) of the registered hazardous waste in the country.

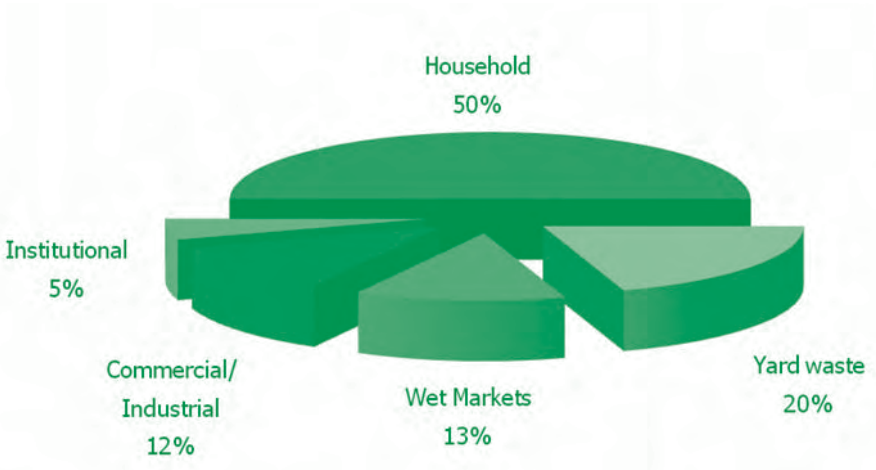
Considering the volume and potential, recycling of paper and plastics assumes top priority in the country. However, hazardous materials such as Used Lead Acid Batteries need to be appropriately taken care of by virtue of their threats to the environment and the country.

Informal sector sorting recyclable waste
Image source: www.conexor.com

URBAN MUNICIPAL WASTE

The rate of solid waste generation in the Philippines is comparable to that of other low to middle-income countries. Recent studies indicate that the per capita waste generation in Philippines is about 0.3 and 0.5 kg/day in rural and urban areas, respectively. The National Capital Region alone accounts for 23% while the Southern Tagalog Regions contribute 13% of the total waste generated annually. Asian Development Bank (ADB) estimates indicate that about 6,700 metric tons of waste is generated every day in Metro Manila alone. The figure below presents the major sources of waste in the Philippines.

In terms of waste composition, a survey conducted in nine cities and ten municipalities under the Philippine Environmental Governance Program of the United States Agency for International Development reveals that around 60% of the solid waste is biodegradable materials. In a study conducted at five Metro Manila cities under the Metro Manila Solid Waste Management Project, it is identified that of the sampled MSW, 60% are biodegradable, 19% are considered as recyclable, 18% are residual while 2% are considered as hazardous or special wastes.



Source of MSW in the Philippines
source: www.3rkh.net

Segregation and collection of solid waste is done at the village district or ward level for biodegradable, compostable and reusable wastes. Collection of non-recyclable materials and special wastes is the responsibility of the respective municipality or city.

Waste from public institutions, together with those collected at the village district or ward level, are then transported by the city or municipality to disposal sites. It is estimated that Metro Manila spends over PHP 3.5 billion (USD 76 million) annually for the collection and disposal of MSW. The League of Cities of the Philippines survey in July 2005 reveals that garbage collection efficiency in cities average at 40% in terms of political area where about 56% of the cities' population is served. Quezon City has reported a collection efficiency of 99% in 2005. In the same survey there were reports that around 90% of the cities operate their own waste collection fleets while 10% contracts this to private haulers. Like other developing countries, informal sectors, especially scavengers play a significant role in the collection, sorting and recycling of urban municipal waste. Local Government Units (LGUs) in 2004 achieved over 31% of waste diversion to landfills/dumpsites mainly due to:

- Massive public education campaigns
- Distribution and implementation of segregation system for recyclable and compostable materials
- Technical and logistical support to townships and NGOs

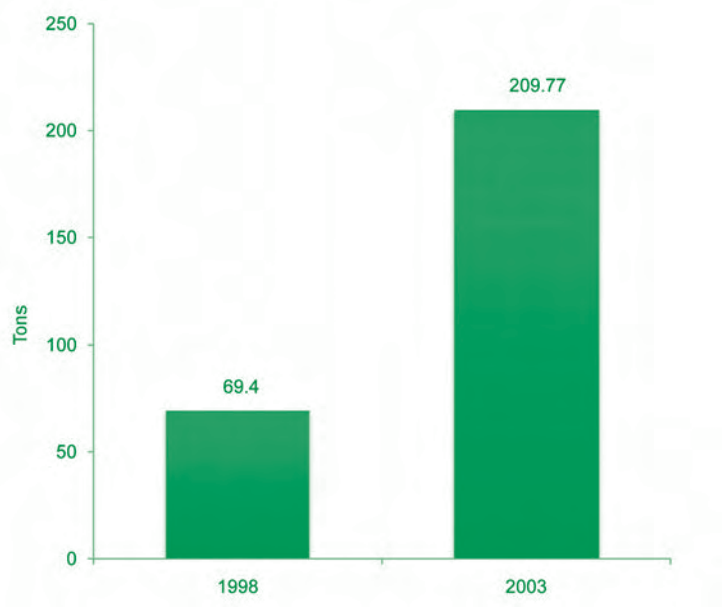
Findings

In most cases, MSW is prevented from going to final disposal through the institutionalization of the Materials Recovery Facilities. While some LGUs employ manual segregation, others have mechanized material separation features. Still, other LGUs promote the "junkshop" approach, wherein the recyclable materials are bought and sold by certain individuals.

Recyclable waste transported from the dumpsite
Image source: www.conexor.com

Recyclable wastes sorted out from the dumpsite
Image source: www.conexor.com

In addition to MRFs, private and NGOs have established their respective collection centers. Examples are the Linis Ganda, Zero Kalat sa Kalinisan, Coca-Cola Bottlers Phils, Inc., Rotary Clubs, Now Trading Concepts, Ayala Foundation, etc. The collective efforts of the government, private and NGOs have significantly reduced the volume of MSW that finally ended up in the landfill. It is interesting to see that the volume of the waste handled or traded by junkshops increased up to three- folds in five years (1998-2003).



Volume of junkshop trades
Source: www.3rkh.net

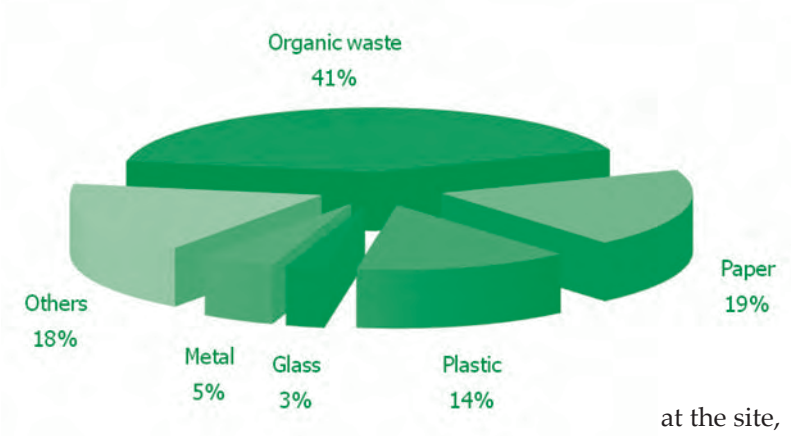
PET Recycling in the Philippines

Poly Ethylene Terephthalate, commonly known as PET finds wide domestic use. PET is non-biodegradable and usually ends up in the landfill. Recent studies in the Philippines indicate that about PHP 791 million pesos (USD 15,400) is spent annually for the handling of PET. Waste analysis and composition studies in the country reveal that PET bottles are rarely present in the waste collected by garbage trucks.

PET waste in the Philippines is categorized as post-industrial and post-consumer. Post-industrial waste is clean and easily segregated, identified or defined. The country generated a total of 576 metric tons of industrial waste in 2001. Post-consumer PET waste, on the other hand, is reclaimed from pushcart boys, directly from garbage bins, materials recovery facilities, junk shops, plastic consolidating and recycling plants, and dumpsites. Compared to industrial waste, these are dirty and at times even contaminated.

To promote the recycling of PET, the Department of Science and Technology, Industrial Technology Development Institute and PET manufacturers and users formed the PET Recycling Task Force in 2000. Recovery centers were set up and fees were determined. Today, about 15 large consolidators, known as Metro Recycling Association export about 400 tons of PET flakes every month as feedstock for the enormous nonwoven fiber factories in China and Korea to produce polyester.

Source: www.3rkh.net



MSW composition in the Philippines
Source: www.3rkh.net

HEALTHCARE WASTE

Hospitals generate about 10,000 tons of healthcare waste annually. There are about 3,670 health care facilities in Metro Manila alone. Based on the recent surveys conducted, it is estimated that these healthcare facilities generate about 47 tons of waste per day. Given the current level of segregation, about 27 tons per day (about 56%), is considered infectious or potentially infectious.

Of the 18 hospitals and clinics surveyed under a study by ADB, all of them are separating sharps such as syringes, scalpels and similar items, from the rest of the wastes. The syringes are usually placed in plastic containers designed to hold sharps (safety boxes) or in other containers such as hard plastic bottles, cans or plastic gallon containers lined with plastic bags. Most of the sharps are given to a private contractor for treatment and disposal. The rest is buried at the site, disposed, incinerated, or burned in improvised combustion units.

Disinfection of infectious waste is carried-out in about 80% of the hospitals surveyed using either steam sterilization or chemical methods. Infectious wastes are stored in yellow plastic bags or in containers that are properly labeled. Almost half of the infectious wastes are given to a private contractor for treatment and disposal. The rest is buried at the site, disposed at a dumpsite, discharged into a sewer, or incinerated. All of the hospitals surveyed indicated that they separate medical wastes from general wastes. Almost all (90%) of the hospitals practice color-coding in storing their wastes while the rest do otherwise. Only three of the hospitals surveyed have access to incineration, either on-site or off-site.

The ADB study further indicates that in dental clinics, veterinary clinics, diagnostic and laboratory clinics, and mortuaries/funeral parlors, general wastes are typically stored in plastic bags and disposed through open burning or collected by a municipal waste collector. Sharps are separated from other healthcare waste and are placed in plastic containers, which are eventually taken to the municipality's dumpsite. Infectious or potentially infectious wastes are not disinfected prior to disposal. Pharmaceutical wastes are directly flushed into the sewer or disposed at the disposal site. Most healthcare wastes currently are separated from the general wastes, but often are mixed with other wastes during disposal.

Healthcare Waste Generation in Metro Manila

Type of Facility	Non-infectious Waste (kg/day)	Total (kg/day)	Infectious Waste (kg/day)
Accredited Hospitals			
Government	5,971	6,850	12,821
Private	3,996	4,584	8.580
Health Centers	802	1,203	2,005
Medical Clinics	2,580	3,870	6,450
Dental Clinics	5,880	1,960	7,840
Veterinary Clinics	372	93	465
Pharmaceutical Labs	5,772	1,443	7,215
Blood Banks	204	51	255
Funeral Parlors	1,176	196	1,372
Medical Schools	132	33	165
Research Institutions	48	12	60

Source: www.3rkh.net

Findings

About five years ago, the Department of Health (DoH) completed the acquisition of various types of equipment (including 25 incinerators and 36 small microwave units) for its hospitals. The capacity of the incinerators ranges from 300 to 500 kg/day while that of microwaves ranges from 84 to 144 kg/shift. Out of the 35 units acquired for DoH facilities nationwide, four are operational, 17 are functional but not operational, and 14 are defective. The DoH reported that 13 microwave units were installed in Metro Manila but only one is operational.

The IWMI facilities charge between PHP 28 and PHP 76 per kg of medical waste collected, treated and disposed. Primarily, the price difference is a function of distance from the treatment facilities. The present incineration facility operated by IWMl does not have air pollution control equipment. Ash collected from the combustion process is disposed on-site in a cement vault. On the other hand, the company providing disinfection by means of microwaves has had formal complaints from neighbors living near the site due to the generation of unpleasant odors. Furthermore, the company currently does not seem to have access to a well-designed final disposal site.

E-WASTE

As far as e-wastes are concerned, no published studies have been conducted to estimate its volume and disposition in the country. It is reported that over a span of 10 years, from 1995 to 2005, about 25 million units of televisions, air conditioners, washing machines, refrigerators, and radios became obsolete. It is projected that by 2010, an additional 14 million will become obsolete.

About two million units of Used Lead Acid batteries (ULAB) are discarded each year. This translates to 26,000 metric tons of discarded lead, four million liters of used sulfuric acid electrolyte, and a significant volume of plastics that can be recycled. Because of the hazardous chemicals in the ULABs, its management is regulated by the Republic Act 6969, also known as the Toxic Substances and Hazardous and Nuclear Waste Control Act of 1990.

Most used lead acid batteries come from automobiles, stand-by power supply and other transportation equipment. As the suppliers have the responsibility of managing ULABs, dealers usually buy them back when customers make new purchases. Recycling of ULABs is done to recover its lead contents, which can be used in the production of new batteries. The escalating cost of lead importation has induced the local industry to develop recycling alternatives.

The Philippine battery recycling industry is characterized by one dominant recycler (Philippine Recyclers, Inc.), a few small licensed, and therefore legitimate recyclers, and thousands of unregulated cottage smelters spread out all over the country. Only the legitimate recyclers have the smelting technology to properly process the scrap batteries to recover metal from battery active materials. The cottage smelters merely melt the metal from batteries and indiscriminately discard their waste non-metallic materials and acid.

The Balik Baterya or battery trade-in program involving more than 300 battery dealers of the Ramcar Group strengthens the recovery of ULABs. Similarly, scrap collection events in industrial zones, commercial centers and communities serve as promotional campaigns as well as networking opportunities to develop agreements with institutions for the committed disposal of their scrap batteries through the program. Partnerships with the small recyclers are also being forged to allow them to become more efficient suppliers of lead and lead bearing materials.

Findings

Only very few facilities handle e-waste in the Philippines. Five of them are small and medium-sized facilities, two are transporters and treaters while three are merely transporters. In the two facilities, one does re-manufacturing and dismantling of personal computers while the other one reclaims nonferrous and precious metals from the waste of the semiconductor firms. These two companies are hardly enough to cope with the large volume of e-waste produced in the country along with imported

second hand goods. There is also not enough landfill area to receive e-waste in the Philippines. For example, it is estimated that for the next 25 years, around 60 million units will be obsolete and would require 8.5 m^3 of landfill space on 57 ha of land. This estimate of e-waste does not take account of computers and only include television, air conditioners, washing machine, radios, and washing machines. As such, recycling facilities are not sufficient to accommodate this volume.

GAPS FOR IMPLEMENTATION OF 3R

Worldwide, experiences indicate that applying 3R is a lucrative way of tackling waste management issues. The first step in this exercise is an assessment of the technology options available for implementing 3R-based solutions. Proactive policies and relevant legislations emphasizing 3R-based solutions are vital to achieve a higher success rate to form the next step. While recycling is considered as technological ability, reduce and reuse is often considered management or policy oriented. In this context, the following sections present information on the technology and management aspects with focus on 3R.

TECHNOLOGY GAPS

In an archipelago like Philippines, with discrete pockets of islands, it is essential that appropriate technology be used to tackle waste management problems at the source. Evidently, transportation of the waste to a centralized processing facility becomes next to impossible owing to high costs. The need to decentralized waste treatment therefore prevails in the country. Importantly, the technologies for waste management are required to focus on 3R.

MANAGEMENT ASPECTS

An assessment of the policies and legislative measures of the Philippines appears to yield positive results. Table presents an overview of the management, legislative and policy aspects of the country.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN THE PHILIPPINES

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	⊙
	Fuel Recovery	⊙
	Material Recovery	●
	Sorting	◍
	Pulverizing	☒
	Composting	☒
	Incineration	⊙
	Collection	◍
E-Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	☒
	Collection	○
Healthcare Waste	Material Recovery	⊙
	Sorting	◍
	Pulverizing	◍
	Incineration	⊙
	Collection	⊙

● Formal, Strong ⊙ Informal, Weak ☒ Technology Gap
◍ Formal but weak ○ Informal but Strong

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	**Framework**	Ecological Solid Waste Management	○
	Direct Regulatory	• Ecological Solid waste Management Act of 2000 ✓ Recycling and Recovery ✓ Eco-labeling & Green procurement • Toxic Substances and Hazardous and Nuclear Waste Control Act of 1990	○
	Economic	• Incentives to facilities and Industry Associations implementing Pollution Prevention programs • Funds from Financial Institutions	○
	Voluntary	• Eco-labeling • Green Procurement • Industrial Waste Exchange Program • Industrial Environmental Management Project • Promotion of ✓ Industrial Eco Park ✓ Solid waste Reduction master Plan ✓ Draft guidelines for EPR	●
	Information	Lack of information for the public and industrial sector	☒
	Procedural	Formulation of standards and levels classifying wastes eligible for recycle. Implementation of ISO 14001- Environmental Management System in government agencies & Business establishment	☒
Support for 3R-related Activities		• Technical assistance from International Development Research Center (IDRC), Canada • Technical and financial assistance from US Agency for International Development (USAID) • Local Government Units • NGOs	○
Environmental Education		Lack of Environmental Education	☒
Science and Technology		Under implementation level	☒
Reduction of Barriers to International Flow		• Response of industries to Basel convention • The Japan-Philippines Economic Partnership Agreement (JPEPA) • Agreement on Transboundary Movement of Hazardous Wastes from the Philippines to the United States (2001)	○
Cooperation of Stakeholders		• International Certification on Environmental Management Systems • Technical assistance from Canada • Technical and Financial assistance from USAID • Information Sharing, Training, Public Awareness ✓ Green Aid Plan, Japan • Pilot Project: ✓ Industrial Environmental Management Project (USAID) for Recycling Information Method • Industrial Waste Exchange Program (Canada, US-AEP) • Private Sector Participation in Managing the Environment (UNDP)	●
International Cooperation		Memoranda of Understanding with NGOs & recycling industries	○
Promotion of Science and Technology for 3R		• Promotion of technology for Waste minimization and recycling and recovery of waste in industries • National Registration of Hazardous waste generation, treatment, storage and disposal	○

● Sufficient ○ Insufficient ☒ Gap

Considering the quantity of waste reaching the incinerators and landfills, it is evident that urban municipal waste is a priority area requiring immediate action with respect to 3R related activities. The Singapore Green Plan 2012 also confirms the understanding that the disposal of urban municipal waste poses an imminent problem...

3.13 Singapore

BACKGROUND

Singapore, an island between Malaysia and Indonesia in Southeast Asia, has a land area of 690 km^2 with a population of about 4.4 million. Industrial pollution, limited natural fresh water resources and seasonal smoke/haze resulting from forest fires in Indonesia are some of the major environmental issues affecting the country. On top of all these issues are the threats stemming from waste management that results from the island's limited land availability for disposal.

Over the last 30-40 years, Singapore has transformed to an urbanized, industrialized and affluent country. This has led to a rising trend in waste generation, producing about 1,200 tons per day in 1970 and growing to 7,000 tons per day by 2005. This growth in solid waste generation places considerable demands on waste management, disposal facilities and the environment.

PRIORITY AREAS

Over the past three decades, the solid waste disposed in Singapore has increased five-fold. Domestic waste increased about three-fold. Non-domestic waste increased even more by about eight-fold mainly from the high growth in the manufacturing and services sectors.

Since 1979, the government has spent billions of dollars to build four incineration plants and sanitary landfills. The incineration plants have been designed to incinerate waste safely and are adequately equipped with air pollution control equipments. They effectively reduce the volume of waste for final disposal in the landfill and also recover energy and scrap metals. Even then, the last landfill on the main island of Singapore was filled up in 1999 and a new offshore landfill at Pulau Semakau had to be developed for non-combustible waste. With the present rate of growth in solid waste, Singapore would need to build a new incineration plant every five to seven years and a new landfill the size of Semakau Landfill every 25-30 years.

Considering the quantity of waste reaching the incinerators and landfills, it is evident that urban municipal waste is a priority area requiring immediate action with respect to 3R related activities. The Singapore Green Plan 2012 also confirms the understanding that the disposal of urban municipal waste poses an imminent problem.

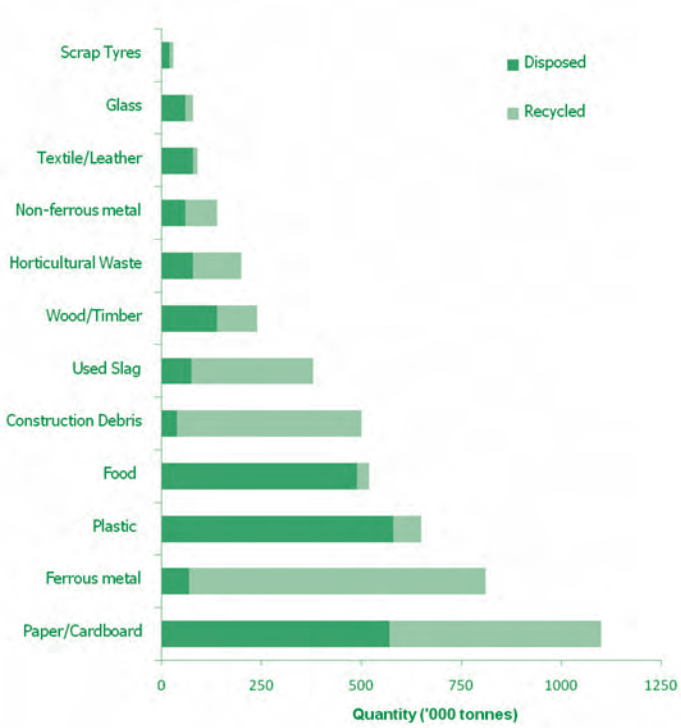
URBAN MUNICIPAL SOLID WASTE

Waste generated in Singapore is broadly classified as (i) domestic and trade waste arising from residential premises, markets, food retail outlets, schools and trade premises (ii) commercial and industrial waste from industrial premises, construction sites and shipyards.

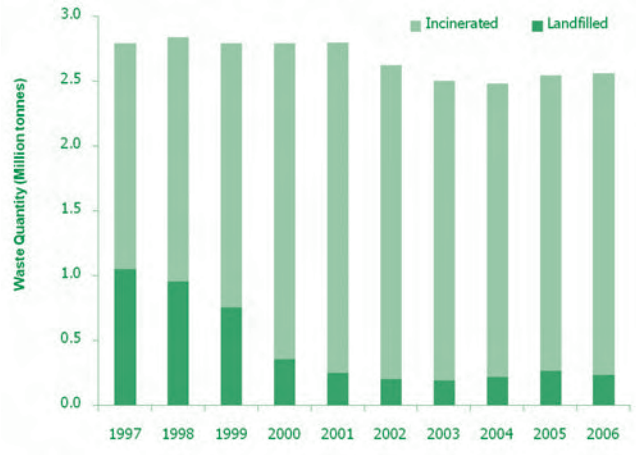
About 2.5 million tons of waste was disposed of in 2006. Nearly, 90% (2.3 million tons) was incinerated while the remaining went to landfills.

From the amount disposed, 57% was generated from residential premises, food centers and markets. Commercial and industrial premises accounted for the remaining 43%. The per capita waste generation in 2006 was 0.89 kg/day.

The efforts of the Singapore Government in promoting recycling as a means of reducing the load on incinerators and landfills has proven to be fruitful. This has resulted in a decreasing rate of waste reaching the incinerators and landfills in recent years. The figure below presents information on recycling rates and waste disposal in Singapore.



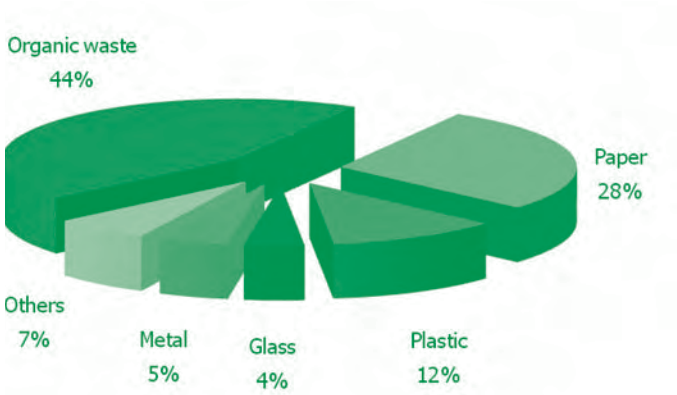
Waste Recycling in Singapore
Source: www.3rkh.net



Waste Disposal in Singapore
Source: www.3rkh.net

In Singapore, 90 % of the waste is incinerated at the four plants (Ulu Pandan, Tuas, Senoko and Tuas South) and the remaining 10% of non-combustible waste are disposed at the Semakau Offshore Sanitary Landfill. Incinerating waste has reduced the volume of waste to 90% and has satisfied nearly 3% of electricity demand for Singapore through energy recovery.

About 980 million kWh of electricity is generated/year and 22,800 tons/year of scrap metal is recovered for recycling from the incineration facilities. About 600 tons/day of non-incinerable waste and 1,400 tons/day of incineration ash is disposed of at Semakau landfill. The waste treatment facilities found in Singapore are four waste-to-energy plants, one landfill, one biological treatment facility and 10 recycling units for paper and plastic.



Urban Waste Composition in Singapore
Source: www.3rkh.net

Findings

The public waste collection scheme is built on a collective platform where pre-qualified waste management companies compete to provide refuse collection services for the designated domestic and trade premises in the island's nine geographical sectors. They also need to provide door-to-door collection services for recyclable materials from the households in their sectors under the National Recycling Program. Presently, four public waste collectors are providing the collection services in the nine sectors.

The National Recycling Program for households was introduced by the National Environment Agency (NEA) in 2001 to provide a convenient means for the public and private housing estates to recycle their waste.

Pilot Scale Recyclable Intermediate Chute Storage System (RICH System)

System Brief:

- Used in High-rise buildings, offices, multi-storey housings
- Refuse thrown into common/ individual chutes
- Channeled to common storage tank
- Sucked out by a Pneumatic system
- No need for manual transfer of refuse
- Innovative method for storing recyclables within the chute
- RICH System - Helping to reach the recycling target of 60% by 2012

Image source: Semb Waste Consultancy & Technology, Singapore

Participation by households increased from 22% in 2001 to 56% in 2005. An additional 5,200 recycling bins for paper, plastic, metal cans and glass bottles were set up in public places. Installation of about 1,600 centralized depositories by 2007 in all high-rise public housing estates has been planned to make recycling even more efficient. Non-legislative means of promoting waste recycling with joint efforts such as 3P (People, Private and Public), as in the case of the Singapore Green Plan 2012, has been carried out. The NEA has also established a USD 600,000 partnership fund to foster environmental awareness and ownership of the environment.

Activities such as the Recycling Corner Program for Schools have been launched by the NEA, together with recycling companies and the Singapore Environment Council. An increase in recycling rates from 30% in 2003 to 78% in 2005 has been observed in the schools. To raise awareness and educate the public and private sector on recycling, an Annual Recycling Day is held with greater participation from schools and Singapore's youth. In addition, an Annual Clean and Green Week has been held every year since 1990 and aims to increase the level of public awareness about environmental issues. All these combined efforts have increased the overall recycling rate from 40% in 2000 to 49% in 2005, with a target of 60% set for 2012.

HEALTHCARE WASTE

An integrated Healthcare Waste Management System (HWMS) has been in place since 1988 in Singapore. As most hospitals are located within water catchment areas, there is a critical need to manage healthcare waste in a safe way that avoids possible groundwater contamination.

Bio-hazardous waste, how healthcare waste is categorized in Singapore, is segregated at the source and stored in color-coded plastic bags. They are then put in secured containers and collected by licensed bio-hazardous waste disposal companies for disposal in high temperature incinerators.

Currently, Singapore has two licensed hospital waste disposal contractors that operate dedicated high temperature waste incinerators to dispose the bio-hazardous and used cytotoxic wastes collected from hospitals and healthcare institutions. Other activities have also initiated improvements in HWMS and increased the involvement of hospitals in green practices. For example, the Singapore Environmental Achievement Award was awarded to Changi General Hospital and Alexandra Hospital for their overall environmental initiatives and organizational awareness.

Findings

Health care waste management in Singapore is managed at the national level by a committee comprising representatives from the National Environment Agency (NEA), Ministry of Health (MoH) and Ministry of National Development of Singapore. Specific guidelines are provided by MoH for all healthcare institutions licensed under the PHMC Act as well as regular audits to ensure compliance. Only licensed collectors are allowed to gather and incinerate bio-hazardous waste in their approved high temperature incinerators.

Though there are notable hospitals engaged in green practices and waste minimization, a general lack of information on the level of 3R and waste minimization adopted in hospitals still prevails.

E-WASTE

In a technologically advanced country like Singapore, tackling e-waste is an important task. A survey released by Infocomm Development Authority of Singapore shows that an overwhelming 84-85% of those in the age group 10-29 are computer users. According to the NEA, the situation of e-waste is not worrisome as most electronic goods such as computers, printers and hand phones are either traded-in where new sets are bought, or resold to secondhand dealers. The used electronics bought or collected by these traders are either refurbished and exported overseas for reuse, or sent to local recycling facilities. There are several electronic waste recycling facilities in Singapore where electronic waste, or e-waste, is taken apart and useful materials such as metals and plastics are recovered for recycling. Precious metals such as gold, silver and platinum are also extracted from some e-waste. Currently no reliable data source is available for the generation of e-waste in Singapore, but NEP is satisfied with the current situation and it continues to review the situation regularly.

Available information indicates that one company, Citiraya in Singapore, collects and recycles e-waste from around the world. Since around 1990, Citiraya has been operating a recycling business for wastes, such as defective products generated by the semi-conductor industry during production to recover the precious metals contained. The company takes computers and other electronic goods collected by manufacturers and clients, primarily corporations, in China and other countries. Citiraya has also invested in pollution controls and reports the results of gas emission and effluent monitoring to the Ministry of the Environment. An e-waste recovery plant has also been reported in Tuas. In addition, the Cimelia Resource Recovery is among a handful of recyclers in Singapore that handle electronic waste.

Findings

Information on generation and recycling rates of e-waste in Singapore is not currently available though there are several recycling facilities available for electronic waste. Sufficient and clear information about recycling of different types of electronic waste is not available.

GAPS FOR IMPLEMENTATION OF 3R

TECHNOLOGY GAPS

Waste management has been an ever-pressing issue for the country owing to its limited land area and drastically changing consumer preferences. Industrialization and an increasing flow of goods due to the country's strategic location have widened the waste management horizon. Presently, the country relies predominantly on incineration which is followed by landfill disposal. However realizing that these approaches are not sustainable, the government has started turning towards recycling and resource recovery. With proactive policies and legislative measures in place, the country is moving forward in this direction. As far as applying 3R is concerned, it appears that appropriate technologies are either not available or are not reported.

MANAGEMENT ASPECTS

Singapore has announced plans to become the recycling center of the ASEAN region. It set up a task force in 2001 comprising representatives from the Economic Development Board, the Trade Development Board (now International Enterprise Singapore), the Productivity and

Standards Board (now the National Science and Technology Board), and others, which compiled an action plan aimed at making Singapore a Center of Excellence for recycling in the ASEAN region within 10 years. This action plan highlights the following four areas:

- To create a pro-environment culture both in the corporate world and in the community.
- To develop an effective supporting infrastructure to help nurture the waste-recycling industry.
- To build strong foundations for technology development and innovative application of technology.
- To create a vibrant waste management industry.

Singapore is one of the countries in Southeast Asia known for its rapid industrialization. Its growth in recent years has attracted, tourists, and a significant migrant population in search of employment opportunities. All these, both directly and indirectly, reflect in the form of pressure to meet the country's needs. With constraints on availability of land and increasing movement of goods, tourists, and migrant populations; it is important that the country takes proactive measures to maintain its present environmental condition.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN SINGAPORE

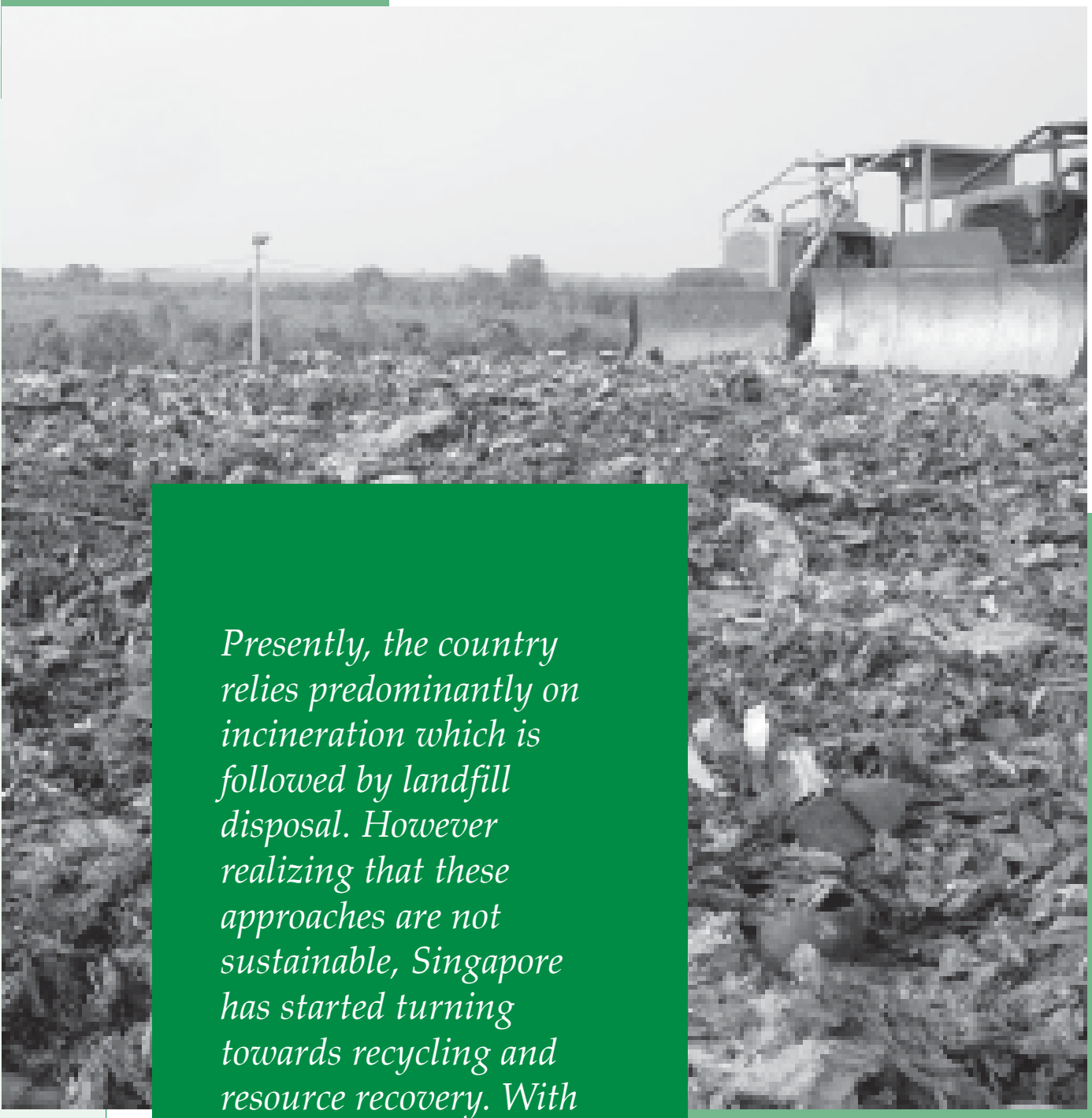
	Reduce	Status	Reuse	Status	Recycle	Status
Urban Municipal Waste	Resource Conservation Product Lifetime Extension Waste Reduction	● ●	Easier Disassembly Remaining Life Assessment	●	Thermal Recovery Fuel Recovery Material Recovery Sorting Pulverizing Composting Incineration Collection	● ● ⭘ ☒ ☒ ☒ ● ●
E-Waste	Resource Conservation Product Lifetime Extension Waste Reduction	☐ ☐ ☐	Easier Disassembly Remaining Life Assessment	☐ ☐	Material Recovery Sorting Pulverizing Collection	⊙ ⊙ ☒ ☒
Healthcare Waste					Material Recovery Sorting Pulverizing Incineration Collection	● ☒ ☒ ● ●

● Formal, Strong
⭘ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap
☐ No Information

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

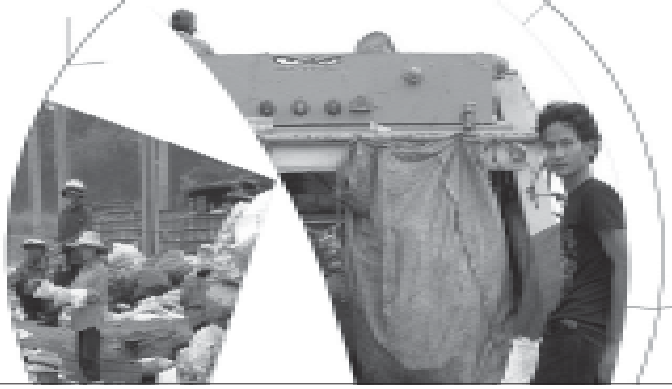
3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-Economic Activities	**Framework**	National Target for Recycling Singapore Green Plan 2012 Zero Landfill and Zero Waste Strategy	○
	Direct Regulatory	• Recycling ✓ National Recycling Program (NRP), 2001 for households ✓ Public Recycling Bins ✓ Recycling Corner Program, 2002 for schools ✓ Recycling Program in Industrial Estates & Commercial Buildings • Zero Landfill ✓ Waste reduction to landfill ✓ Waste minimization ,reducing use of plastic bags ✓ Volume reduction through Incineration	●
	Economic	Innovation for Environmental Sustainability (IES) Fund NEA 3P Partnership fund	○
	Voluntary	Waste management &Recycling Association of Singapore, 2001 Singapore Green labeling scheme, 1992	○
	Information	Brochures, Newsletters and NEA Website Singapore Green Labeling Scheme	○
	Procedural	Lack of systems for environmental quality surveillance	☒
Support for 3R-related Activities		• Ministry of Environment & water resource • Waste management & Recycling Association of Singapore	○
Environmental Education		Raising professionalism of workers in industries Public awareness and educational Activities	☒
Science and Technology		Memorandum of Understanding with Universities in Singapore to carry out Research and Development in recycling	○
Reduction of Barriers to International Flow		The Hazardous Waste (Control of Export, Import and Transit) Act, 1997 Singapore is a signatory to the Basel Convention. However, the amendment to the Basel Convention (Decision III/1) has not been implemented in Singapore	○
International Cooperation		• Singapore Cooperation Program ✓ Conducting training Programs on waste management for other countries in the region • Third Country Training Program ✓ Collaborating countries, regional partners, international organizations developing countries ✓ Cooperation with Swiss Government	○
Cooperation of Stakeholders		Cooperation between community, private sector, schools, industrial estates, commercial establishments, government other Asian countries	○
Promotion of Science and Technology for 3R		• Research and technology development: ✓ Development of Innovative Environmental technologies under "Innovation for Environmental Sustainability" ✓ Memorandum of Understanding of National Environmental Agency, Singapore with Universities for joint R & D projects	○

● Sufficient ○ Insufficient ☒ Gap



Presently, the country relies predominantly on incineration which is followed by landfill disposal. However realizing that these approaches are not sustainable, Singapore has started turning towards recycling and resource recovery. With proactive policies and legislative measures in place, the country is moving forward in this direction...

Around 64 million tons or 75% of the total agricultural waste is either un-utilized or under utilized. Considering the availability and potentials of the agricultural wastes in the country, it is essential that they be considered with top priority to make the best possible use...



3.14 Thailand

BACKGROUND

Thailand is one of the newly industrialized countries of Southeast Asia located centrally in the Indo-China Peninsula with a total area of 514,000 km^2. Of the 64 million population 22% live in urban areas. The country's economic growth rate was at 8.2% during 1981-91, which decreased to about 4.6% in 2000 due to the Southeast Asian economic crisis in 1997. The urban dwellers are concentrated in the Bangkok metropolis with a population of about 10 million. Solid waste generation has witnessed a rapid upwards trend parallel to its economic growth and industrialization.

The country's strategic location in Southeast Asia attracts industrial investments due to conducive policies and fiscal rebates. Of late, the country is known as the "Detroit of Asia" and "Kitchen of the World". Not to mention the side effects of industrial development; resource depletion and waste disposal concerns. Though the country does not face any serious resource threats, the Government has been proactively tackling environmental issues.

PRIORITY AREAS

Thailand has traditionally been an agrarian country with vast land areas devoted for cultivation. Industrialization and modernization have been happening only in recent decades. Agriculture is still practiced in various parts of the country. Agricultural waste represents a major fraction in the rural areas. Primarily, there are ten kinds of agricultural waste that have the potential to be reused-residues from rice, cane, corn, coconut, palm, cassava, peanut, cotton, soybean and sorghum. Roughly 22 % or 18 million tons of the total agricultural waste out of 82 million

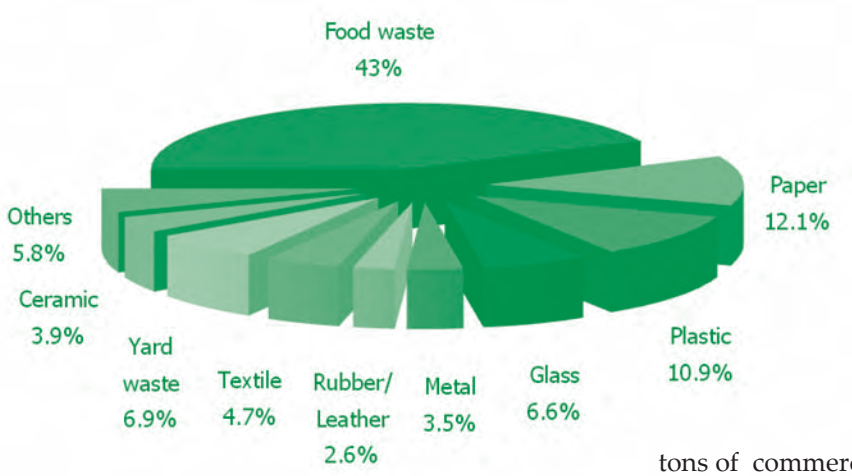
tons has the potential to be reused for various purposes. The majority of agricultural waste is utilized for renewable energy generation. Around 64 million tons or 75 % of the total agricultural waste is either un-utilized or under utilized. Considering the availability and potentials of the agricultural wastes in the country, it is essential that they be considered with top priority to make the best possible use.

URBAN MUNICIPAL WASTE

Thailand produces around 46,000 tons of non-hazardous solid household waste per day. The Pollution Control Department (PCD) of the Ministry of Science, Technology and Environment, estimates municipal solid waste generation is growing about 4% per year.

Municipal solid waste in Thailand is from three regions: the Bangkok metropolitan generating aout 25% of the total waste; urban centers in the provinces about 35%, and rural provincial areas, which produce the remaining 40%.

Future solid waste generation depends upon the population growth, consumption, recycling and reuse. Waste composition can be influenced by external factors, such as the population's standard of living, geographical location, and the weather.



Waste composition in Thailand
Source: www.3rkh.net

Thailand spends an estimated USD 41 million a year on goods and services for MSW management. The solid waste industry is characterized by unsafe practices of open dumping and inefficient administration due to heavy governmental subsidies. However, economic and regulatory pressures are slowly driving the market to adopt a timely and efficient solid waste management technique.

Approximately 40% of Thailand's municipal solid waste is glass, plastic, paper, and metal. These materials have a potential to be recycled and reused commercially in various manufacturing and industrial activities. The Pollution Control Department reports that more than 1.5 million tons of MSW is recycled each year amounting to 11% of the total waste generated. Bangkok alone recycles 15% of its waste; the municipal areas recycle 16% while the non-municipal areas recycle 5-8% of their waste. However, almost 4.5 million tons of commercially recyclable materials are discarded each year. The potential market value of these materials is THB 16 billion per year. Metal and paper, in particular, have tremendous recycling potential and approximately two-thirds of these recyclable materials are currently discarded. The potential of reuse and recycling strategy offers an opportunity to deal the waste in a sustainable manner.

Solid Waste Generation Profile of Thailand

INDICATOR	VALUE
Municipal solid waste generation (tons/yr)	14.40 million
Hazardous waste produced by community activities (tons/yr)	0.38 million
Hazardous waste produced by industries (tons/yr)	0.96 million
Non-hazardous waste produced by industries (tons/yr)	5.90 million
Hazardous and infectious waste from medical facilities (tons/yr)	21,300
Collected municipal waste	
• Bangkok	>95%
• Medium-sized cities – (Maung municipalities)	86%
No. of solid waste disposal sited in Thailand	
• Organized dumpsites	95
• Open dumps	330
Infectious waste treated	46%
Community generated hazardous waste treated or reused	53%
Infectious waste treated in centralized treatment facilities in Bangkok and its vicinity	24%
Municipal waste recycling and reuse (Portion of total waste generated)	
• National	11%
• Municipal areas	16%
• Non-municipal areas	5-8%
Recycling by industries (Portion of toal waste generated in Bangkok and its vicinity	
• Hazardous waste	18%
• Non-hazardous waste	78%

Source: Thailand Environment Monitor, 2003

Findings

Appropriate policies and enforcing legislations are the primary steps in solid waste management. Solid waste generation in Bangkok has doubled from about 3,300 tons/day in 1985 to 6,600 tons/day in 1995, to 8300 in 2005. Evidently, solid waste generation is increasing each year. However, not only is the amount of waste production changing, but also the waste composition. In this regard, it is essential to consider that all waste must be collected, sorted accordingly and recycled or reused where possible. Other materials should be properly disposed. Private sector enterprises play a huge role in managing e-waste in Thailand. The Wongpanit Recycling Plant is an icon of 3R business in Thailand. The company recently sought new types of waste capable of being recycled such as polystyrene foam and e-waste. The company began as a small junk shop in 1974 in the province of Phitsanulok in northern Thailand. The business now covers the purchase of non-toxic industrial waste from local suppliers and its transformation into usable raw materials for further manufacturing as well as products. The most notable feature in solid waste management in Bangkok is BMA's policy of 10% reduction of solid waste per year using the concepts of 3R. Strategies adopted for implementation of these policies can be pulled together as follows (Amin *et. al.*, 2007):

- Waste generation prevention
- Waste utilization
- Proper waste disposal and landfilling of hazardous waste
- Improvement in the waste collection efficiency and practices
- Promoting public participation
- Enhancing collection efficiency
- Privatizing collection and disposal of infectious waste

There are ample cases of successful community-based solid waste management throughout Thailand, mostly focusing on recycling and reusing, but not so much on waste reduction. Most of the thinking and activities are still focused on how to deal with the waste that has already been produced.

Revealing poor source separation of MSW
Image source: Asia link TETRAWAMA Project, 2006

Wongpanit Garbage Recycling Plant (Phitsanulok)
Image source: Wongpanit

MSW Collection fleet, Sai Noi dumpsite

Dumpsite

HEALTHCARE WASTE

The Thai institutions that deal with technical matters of healthcare waste management include the Pollution Control Department (PCD), the Department of Health (DH) and the Bangkok Metropolitan Administration (BMA). Each institution carries out its own functions rather independently. However, because of differences in the definition of healthcare waste used by each institution, there is inconsistency in the basic data pertaining to healthcare wastes, particularly with respect to the types and generation rate of wastes. Due to reasons cited above, the waste generation rates issued by the BMA, DH and PCD are 0.11, 0.43 and 0.65 kg/bed/day respectively. A DH commissioned study on the disposal of healthcare wastes by incineration revealed that the average waste generation rate was 0.23 kg/bed/day.

By far the most common treatment method of healthcare waste in Thailand is incineration. Presently, the BMA operates two incinerators of 10 tons/day capacity each for the disposal of medical wastes in the Bangkok metropolis. The Department of Public Hygiene (DPH) under the Ministry of Public Health, overseeing the disposal of wastes from hospitals under the Ministry's jurisdiction, has developed standard incinerator designs of 25, 50, and 100-150 kg/hr capacities. According to the Department of Environmental Health, there are 750 medical waste incinerators installed in the hospitals under the jurisdiction of the Ministry of Public Health all over country. Most of these incinerators have deteriorated, prompting the DPH to start importing incinerators to replace the old ones.

Findings

The Department of Public Cleansing (DPC) is responsible for planning and implementing the work of public sanitation and disposal of SW. Since 1988, DPC separates infectious waste from municipal waste during the process of collection, transportation and disposal. DPC has facilities to collect infectious waste from hospitals. Nevertheless, if small health services are excluded as private clinics, the coverage is higher at about 70 %.

The DPH has designed and disseminated the information to almost all the private healthcare establishments in the country for them to construct, maintain and operate their own incinerators. Reports indicate that most of these incinerators have deteriorated over time and at present, necessitate the importation from foreign countries. However, in the present economic conditions there are second thoughts to this alternative. On the other hand, there is rising advocacy on incineration technologies without proper pollution control equipments. In such a situation, it is essential that healthcare waste reduction and management be done by innovative practices and approaches such as 3R.

E-WASTE

In Thailand, production, import, and consumption of electrical and electronic products are increasing significantly, thus creating new challenges and environmental issues. Thailand government started to focus on e-waste in 2004 when Pollution Control Department (PCD) established the first research survey, the field survey on discharging of Waste Electric and Electronic Equipments (WEEE) by JETRO in 2004. In Thailand, electrical and electronic industries play a very important role in economy. Data from the Department of Business Economics, Ministry of Commerce shows that the export of electronic products has been the highest among all industries. The main export products include computers, parts, and printed circuit board.

Medical waste collection and incineration BMA

Image source: www.3rkh.net

In the industrial sector, e-waste is generated during the manufacturing and assembling processes. The survey done by the Ministry of Industry indicates that e-waste accounts for about 10,200 tons of waste/year. In 2003 the amount of e-waste from households in Thailand was referred to be nearly 90,000 tons/year. Thus, it could be observed that the e-waste from manufacturers is only 11% of the total e-waste generated in the country. E-waste from the manufacturing process is not significant in the overall generation. The households' e-waste is of primary concern in the current management situation in Thailand.

Findings

There are many informal sector recyclers around Bangkok working as waste collectors, scrap dealers, and waste transfer dealers. Most of the e-waste from households are dismantled and recovered by these informal sectors. The informal separators separate recyclable e-waste materials (60-70%) and sell them to waste transfer dealers. Wat Suan Kaeo is one of the important informal separators collecting the e-waste generated. Waste transfer dealers sell recyclable parts to the material recycling industry. Most e-waste activities such as dismantling and material recovery are done by bare hands or with small tools in scrap yards or in their own houses.

In Thailand, only 12 industries carry out e-waste separation and recycling activities. All of the industries are small scale, using simple techniques of dismantling and separation. The workers in recycling factories are often being exposed to hazardous chemicals by inhalation or direct skin contact with the chemicals during the process of valuable materials recovery.

GAPS FOR IMPLEMENTATION OF 3R

Worldwide, experiences indicate that applying 3R, Reduce, Reuse and Recycle is a lucrative way of tackling waste management issues. The first step in this exercise is an assessment of the technology options available for implementing 3R-based solutions. Proactive policies and relevant legislations emphasizing 3R-based solutions are vital to achieve a higher success

E-waste from Industries in Thailand

Categories	Amount (tons/year)
Wires	1,818
PCBs	688
Electronic parts	4,274
Unqualified products	1,589
CRTs	1,822
Total	**10,191**

Source: Chinagarn Kunacheva, 2006

Local scrap dealers choice-'E-waste'
Image source: Chinagarn Kunacheva, 2006

Household E-waste in Thailand

Type of Appliances	Sales in 2003 (piece)	Weight (kg)	Sales in 2003 (Tons)	Replacement Factors	Appliances Generated as Waste	
					(Tons)	(piece)
Washing machine	580,000	49.2	28,536	0.51	14,553	295,800
Refrigerator	1,000,000	40.8	40,800	0.82	33,456	820,000
Air Conditioner	340,000	51.4	17,476	0.67	11,709	227,800
Television	1,900,000	25.3	48,080	0.53	25,477	1,007,000
Computer	750,000	5.2	3,900	0.36	1,404	270,000
Computer Monitor	550,000	10.5	5,775	0.20	1,155	110,000
Mobile phone	21,730,000	0.1	2,173	0.44	956	9,561,200
TOTAL			**36,640,000**	**146,730**	**88,710**	**12,291,800**

Source: Chinagarn Kunacheva, 2006

E-waste recycling at the Wongpanit plant (Phitsanulok)
Image source: Wongpanit

rate to form the next step. While recycling is considered as technological ability, reduce and reuse is often considered management or policy oriented.

TECHNOLOGY GAPS

Thailand has been able to recover itself from the 1997 Asian crisis by employing appropriate technologies for its production processes. Moreover, Thailand is possibly one of the countries in Southeast Asia adopting advanced technologies. The mere nature and scale of production in the country demonstrates this feature. Waste management in Thailand also adopts appropriate technologies and good practices. Though the country has been taking all initiatives in improving the waste management system, it is high time that it also focuses on closed-loop material cycles to improve resource efficiency.

MANAGEMENT ASPECTS

In addition to adopting advanced technologies, Thailand also has an excellent administrative and management system that foresees issues and formulates plans. Its revival from the Asian crisis is an example of the countries proactive response system.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN THAILAND

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	⊙
	Fuel Recovery	⊙
	Material Recovery	⊙
	Sorting	☒
	Pulverizing	☒
	Composting	○
	Incineration	⊙
	Collection	⊙
E-Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Collection	⊙
Healthcare Waste	Material Recovery	☒
	Sorting	☒
	Pulverizing	☒
	Incineration	●
	Collection	⊙

● Formal, Strong
⊙ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	National Integrated Waste Management Plan National Master Plan on Cleaner Production Technology	○
	Direct Regulatory	• Industrial Waste Management • E-waste Management with Polluter Pays Principle • Plan on Packaging and Packaging Waste Management • Pilot Program on Plastic and Foam Waste Recycling	○
	Economic	Financial support by National and Provincial Governments to Local Government and Private Sector	○
	Voluntary	• Green Label Scheme • Take Back Schemes for End-of-Life Products • Waste Exchange Programs • Green Purchasing Network	○
	Information	Waste Management Programs Guidelines for Waste Management	○
	Procedural	Lack of systems for environmental quality surveillance	☒
Support for 3R-related Activities		• Ministry of Natural Resources and Evironment • Ministry of Industry • Financial and Technical Support by Central Government of Thailand • Private Agencies • Support from Government of Japan, Government of Germany and UN agencies through International Technical Programs	○
Environmental Education		Lack of Mechanisms for Environmental Education	☒
Science and Technology		Promotion of Science and Technology	☒
Reduction of Barriers to International Flow		• Government to negotiate Free Trade Agreements with various countries for the greatest good of the country • Banned the import of used tyres under the Basel Convention 2003	○
International Cooperation		Green Partnership Plan with Government of Japan Flourescent Lamp Partnership Program in cooperation with Government of Japan National Legal Framework, Policy, and Strategy • Construction and Demolition Waste Management System project by GTZ and Pollution Control Department For information sharing, training and public awareness • Green Aid Plan, Japan Reduce: Pilot Project • Promotion of Cleaner Technology in Thai Industries Recycle: Pilot Project • Economic Incentives Solid Waste Bank (CIDA)	●
Cooperation of Stakeholders		Initiation of Recycling-oriented Society: • Cooperation among all stakeholders; National Government, Provincial Administration and Private Sector • Community Participation, Industries • Cooperation with other Asian Countries and Agencies	○
Promotion of Science and Technology for 3R		Development of Technology for: • Material Recovery • Plastic and Foam Waste Management • Green Purchasing Network	○

● Sufficient ○ Insufficient ☒ Gap

About 160,000 tons per year (1%) of Vietnam's waste is considered hazardous, including healthcare waste from hospitals; toxic or flammable waste from industrial processes; and pesticides from agriculture. If not appropriately managed, hazardous properties of this waste pose significant threats to public health and the environment.

3.15 Vietnam

BACKGROUND

In recent decades, Vietnam has witnessed soaring economic growth with a parallel increase in urban population. Rapid economic development has enabled more than 20 million Vietnamese people to escape poverty over the past decade. The national GDP has doubled within 10 years with positive changes in the economic structure. The proportion of GDP from the industrial sector rose from 22.7% to 36.6% while the services sector increased from 38.6% to 39.1%. This led to a decrease in the agriculture sector from 38.7% to 24.3%. With these present trends, Vietnam is forecast to become one of the fastest growing economies in Southeast Asia with a projected growth rate of a steady 7.5% over the next decade.

In the last 20 years, especially after the *Doi-Moi*, the country has been able to achieve an average industrial growth rate of 12-15% annually. New industrial and commercial centres have been established and developed, accompanied by the emergence of new urban areas (district towns, urban centres of commune clusters, etc.). However, the issue of waste has become greater, attracting the interest of all sectors in society: from residential communities to managers and policymakers.

PRIORITY AREAS

Vietnam produces over 15 million tons of waste each year from various sources. More than 80% (12.8 million tons/yearr) is from municipal sources, including households, restaurants, markets, and businesses. Industries generate over 2.6 million tons of waste (17%) each year, making it the second most significant source. About 160,000 tons/year (1%) of Vietnam's waste is considered hazardous, including healthcare waste from hospitals; toxic or flammable waste from industrial processes; and, pesticides and pesticide containers from

Province/ City	Generated (tons)	Collected (tons)	Efficiency (%)
Hanoi	722,000	585,000	81
Hai Phong	290,000	200,000	69
Da Nang	226,000	180,000	80
Quang Nam	127,700	95,000	74
Khanh Hoa	175,200	146,000	83
Ho Chi Minh	2,336,000	1,752,000	75
Dong Nai	293,500	176,000	60
Ba Ria-Vung Tau	97,300	58,400	60
Can Tho	107,100	80,300	75

Source: Cuong, 2004

agriculture. If not appropriately managed, the toxic, carcinogenic, hazardous healthcare, and other hazardous properties of this waste pose significant threats to public health and the environment.

About 80% of the 2.6 million tons of industrial waste generated each year comes from industrial centers in the North and South. Ho Chi Minh City and surrounding provinces generate nearly 50% of the country's industrial waste, while 30% is generated in the North Coast–Red River Delta region. Additionally, the nearly 1,500 craft villages, predominantly found in rural areas in the North, produce 774,000 tons/yr of non-hazardous waste. Issues related to waste management are diverse and differ based on various aspects from generation patterns to treatment and disposal technologies, to intensity of problems created. However, this study focuses primarily on urban municipal wastes, healthcare and e-waste. Essentially, this gap analysis attempts to investigate and present the current state of generation, characteristics, technologies, policies and legislation for the focal sectors: urban municipal, healthcare and e-waste.

URBAN MUNICIPAL WASTE

In Vietnam, urban areas contain a meager 24% of the country's population, but produce over six million tons, (50%) of the country's municipal waste. This is due to the more affluent lifestyles, larger quantity of commercial activities, and more intense industrialization found in urban areas. These activities also increase the proportion of hazardous waste (such as batteries and household solvents) and non-degradable waste (such as plastic, metal, and glass) found in urban waste.

Findings

Packaging waste is becoming more popular and difficult to decompose. The proportion of packaging waste to total waste is also on the rise. Vietnam is accelerating its industrialization and modernization processes and experiencing rapid urbanization. People tend to use more and more packaging of various kinds and most are nylon-based and difficult to decompose. Consequently, non-degradable waste will assume a larger proportion of urban solid waste and make it more hazardous.

As a result of changing consumption patterns, the proportion of nylon bags and packaging is on the rise, increasing the amount of recyclable items. The amount of recyclable waste in Hanoi was nearly 5.5% in 1995 and 29% in 2003. Higher amounts of recyclable waste is also noted in other major cities. This presents an

Solid Waste Generation Profile of Vietnam

INDICATOR	VALUE
Municipal solid waste generation (tons/yr)	
• National	12,800,000
• Urban areas	6,400,000
• Rural areas	6,400,000
Hazardous waste produced by industries (tons/yr)	128,400
Non-hazardous waste produced by industries (tons/yr)	2,510,000
Municipal waste generation (kg per capita/day)	
• National	0.4
• Urban areas	0.7
• Rural areas	0.3
Collection of waste (% of waste generated)	
• National	71%
• Rural areas	<20%
• Among urban poor	10-20%
No. of solid waste disposal facilities	
• Dumps and poorly operated landfills	74
• Sanitary landfills	17
Capacity for hazardous healthcare treatment (% of total)	50%

Source: VEM, 2004

opportunity for waste recycling businesses which is in line with Vietnam's policy to establish a waste recycling industry by 2010.

Recycling and reusing are mostly for domestic waste. For many decades, domestic waste has been recycled through the sale or offer of waste to vendors or junk shops. Families usually stock recyclable wastes, such as paper, glass and metal. Informal vendors buy these articles and sell them back to recycling workshops.

Programs on waste separation at sources have been implemented in Hanoi, HCM City, Dong Nai, Hue, Nghe An, Nam Dinh, Hai Phong, Quang Ninh, and elsewhere. However, waste separation remains new for most urban residents. The majority of communities are unaware of the importance or the economical and environmental benefits of solid waste separation at source, even in areas where a separation at source program is in place.

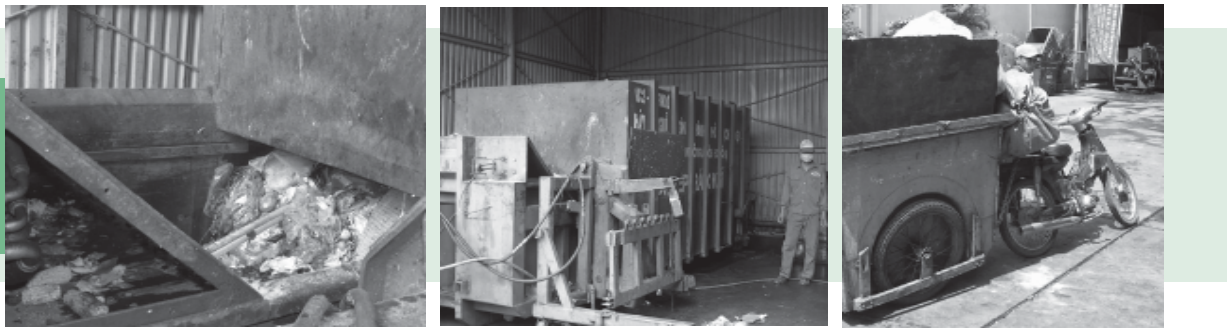
The informal recycling sector has a significant financial impact on local economies. The informal sector collects the majority of the recyclable and reusable waste in urban areas. In 1995, the value of recyclable materials traded by the informal sector in Ho Chi Minh City was estimated to be VND 135 billion, which was to VND 15 billion less than the city's total budget for waste management that year. In Hai Phong, the value of plastics, paper, metal, and glass traded was estimated to be VND 33 billion in 2000. The most recyclable materials were plastics (valued at VND 11 billion), followed by paper (VND 10 billion), and metals (VND 8.5 billion). A 1996 survey of the informal sector in Hanoi estimated that 18 to 22% of all waste was being diverted from the landfill by the informal recyclers. Given that roughly 1.4 million tons of waste is produced in Hanoi every year, savings on disposal costs from recycling currently range from VND 38 billion to 47 billion.

Recycling Rate in Vietnam Handicraft Villages

Recycle materials	Raw materials for recycling (tons/year)	Products (tons/year)	Recycling %
Plastic	25,200	22,900	90
Paper	51,700	45,500	80
Metals	735,000	700,000	95
TOTAL		**768,400**	**95**

Source: Institute of Environmental Science & Technology, 2004

Ba Lai SW Transfer Station District 6 in HCMC
Image source: Dr. N.P. Dan, HCMC University of Technology



Tran Binh Trong Transfer Station
Image source: Dr. N.P. Dan, Ho Chi Minh City University of Technology

Tetra Pak Recycling Initiatives

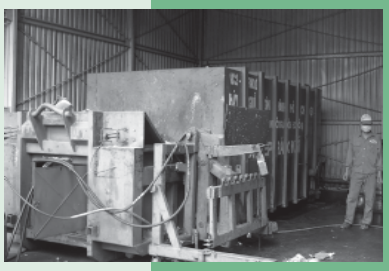
In Vietnam, Tetra Pak – a global company providing food processing and packaging solutions recycled over 18 tons of used cartons in 2006 and nearly 40 tons in 2007.

The company believes in responsible industry leadership, creating profitable growth in harmony with environmental sustainability and good corporate citizenship.

The company is committed to running its business in an environmentally sound and sustainable manner. They are committed to facilitate and promote local collection and recycling activities for post-consumer carton packages. They endeavour to support the customers on finding environmentally acceptable solutions for their packaging material waste.

They also facilitate recycling activities of post-consumer (used) Tetra Pak beverage cartons. Besides supporting and promoting the collection of post-consumer packages they are also involved in promoting environmental awareness programs in schools and societies.

Source: Tetra Pak - Vietnam



Recycled products and Educational programs at school

HEALTHCARE WASTE

Healthcare systems in Vietnam are well-established throughout the country with each province having a minimum of 500 beds. However, Ho Chi Minh City and Hanoi account for 23% of the hospitals in the country. The areas around Ho Chi Minh City, Thanh Hoa Province, and Hanoi City generate about 6,000 tons of hazardous healthcare waste each year. Other provinces generate smaller amounts, from 0.2 to 1.5 tons daily. Even though, most of the hospitals (80%) separate their solid waste at source (stipulated in Regulation on Hazardous Waste issued by Ministry of Health), they are often mixed with general waste at the collection stage. A majority of the healthcare facilities have contracts with local Public Urban Environment Companies (URENCO) for the collection of their waste. Even if hazardous waste is separated from general healthcare waste at the hospital wards and industries, it is commonly re-mixed with common waste prior to collection by URENCO. Healthcare facilities that operate incinerators treat their hazardous healthcare waste on-site and the treated waste and incinerator ash are later collected with others.

Although Vietnam has the capacity to incinerate more than 50% of its hazardous healthcare waste, the majority of incinerators are not operating at full capacity due to financial difficulties. Many incinerators operate only twice a week or 4–6 hours per day. In Hanoi, for instance, where the installed incineration capacity is as high as 70% (3,600 kg/day), the amount of hazardous healthcare waste that was actually incinerated in 2003 varied from 18-33 % of the total. A few hospitals have addressed the problem of lack of financial resources by introducing a special user fee of 1,000 VND per bed per day to cover incineration costs (e.g. Hanoi Tuberculosis Hospital, Vinh Children's Hospital).

Findings

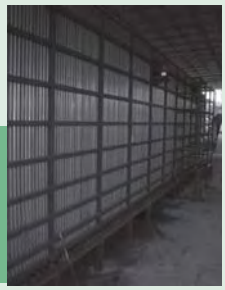
There is a need to develop a coherent and consistent approach to healthcare waste management. It is important to find a suitable mix of technology, operational responsibility, and finance that is appropriate for the different regions and situations in Vietnam. Incineration is the most popular treatment method, although the potential risk of air pollution, including dioxin and furan emissions, is well known. Other methods such as steam and microwave sterilization are under consideration as practical applications.

Vietnam has built about 40 modern medical waste incinerators since 1997, raising its total capacity for incineration of hazardous healthcare wastes by roughly 50% to 28,840 kg/day by 2002. Unfortunately, existing incineration infrastructure is underused and poorly treated hazardous healthcare waste poses high risk. Most of the international and local investments on incineration have focused on equipment, while hospitals are left to finance the operating costs of incineration (training, fuel, personnel) from their existing budgets. Since hospitals do not have sufficient financial resources to operate incinerators, hazardous healthcare waste is often not properly treated, and is mixed with general medical waste disposal. In contrast, the new Cau Dien incinerator, which is centralized and properly operated, helped increase the rate of hazardous healthcare waste treatment in Hanoi from 33% in 2003 to more than 90% in 2004.

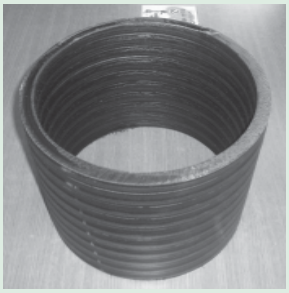
Waste recycling has been a major income source for many communities in Vietnam. However, none of the 3R principles seems to have been applied in the healthcare waste sector. With the recent hue and cry on incineration of healthcare waste and with ever-increasing waste quantities it is essential that appropriate strategies be formulated to both avoid waste-production and to increase recycling rates.

Seraphin's recycling factory

Preliminary Sorting



Composting



Recyled plastic products

Seraphin recycling technology focuses on recycling plastic waste, composting from organic waste and energy recovery. Its scope of business lies in R&D in solid waste recycling technology, investment and operating solid waste recycling plants and transfer of Seraphin's recycling technology.

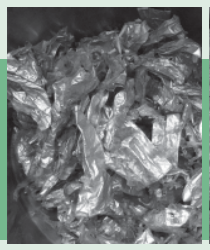
Its major activities in chronological order:

- 2003: Transferred technology for Hue recycling factory (municipal waste)– capacity of 100 tons/day
- 2004: Built its 1st line recycling factory in Vinh with a capacity of 150 tons/day (using landfilled organic MSW to make compost)
- 2005: Built its 2nd line in recycling factory in Vinh - capacity of 150 tons/day (waste sorting, recycling plastic waste and composting and from municipal waste)
- 2006: Built Son Tay recycling factory - capacity of 200 tons/day (waste sorting and composting from municipal waste)

Tetra Pak-Seraphin cooperation

Sorting

Mini pulper



Al and PE residue

Paper fiber

E-WASTE

Vietnam is expected to become a leading transit point for e-waste in Asia. It is not clear how much of the actual disposal will take place in Vietnam. However, the amount of e-waste salvaging is expected to increase significantly. In the present condition, no in-depth e-waste management research in Vietnam has been performed.

Under Vietnam's Law on Environmental Protection, wastes are defined as "substances discharged from daily life, production processes or other activities. Wastes may take a solid, gaseous, liquid or other forms". The import and export of wastes is also prohibited by law. However, there are instances when the restrictions are relaxed at the request of producers wishing to use certain recyclable wastes as raw materials. The ban on exports of wastes has also affected business activity. Technical guidelines on imports and exports of used goods were issued as a Ministry of Science, Technology and Environment Ministerial Decree in 1998, but were abolished in 2003.

Trade in used electric and electronic goods is currently unrestricted. The area around Ton That Dam Street in Ho Chi Minh City is lined with businesses selling imported used PCs. Meanwhile, used Japanese radios and audio equipment are on sale in Hanoi. Secondhand construction equipment from Japan and Korea is being sold in large quantities along national highways on the outskirts of Hanoi and Ho Chi Minh City.

Findings

There is no reliable data available on quantity and nature of e-waste. However, some statistics in the country confirm a high magnitude of hazardous waste.

The Vietnamese internal electronics industry is sluggish, but growing. Except for a few IT majors who operate manufacturing facilities in Vietnam, the country lacks a significant market in high-technology exports. The limited size of the domestic electronics industry indicates that domestic production accounts for very little e-waste. Furthermore, the number of personal computers is relatively small even though it continues to grow at a double digit pace.

The Vietnamese government has started recognizing the need to balance industrial growth with proper disposal of hazardous waste. Major cities have made industrial waste control and management as top priorities for their urban development strategies. For instance, Ho Chi Minh City's authorities have started a relocation program to move polluting factories from residential areas to other regulated zones or industrial parks.

GAPS FOR IMPLEMENTATION OF 3R

Worldwide, experience indicates that applying 3R can be a lucrative way to tackle waste management issues. The first step in this exercise is an assessment of the technology options available for implementing 3R-based solutions. Proactive policies and relevant legislation emphasizing 3R-based solutions are vital to achieve a higher success rate to form the next step. While recycling is considered as a technological approach, reduction and reuse are often considered management or policy-oriented. In this context, the following sections present information on the technology and management aspects with a focus on 3R respectively.

TECHNOLOGY GAPS

Vietnam's solid waste management needs are substantial in relation to existing capacity and the continued growth of urban areas and industrial development. Without undertaking the necessary measures to establish effective handling, treatment, and disposal systems, the growing quantities of waste can have various impacts, from increased health risks to environmental degradation.

MANAGEMENT ASPECTS

Vietnam has been able to achieve amazing growth rates with the help of proactive policies and preventive legislation. As a country built on communist principles, Vietnam has stronger than average policy and management frameworks aimed at overall national development. Though the country has better policies compared to its counterparts in the region, an assessment of policy, legislative and management aspects is essential to understand the present situation.

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN VIETNAM

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	☒
	Fuel Recovery	☒
	Material Recovery	○
	Sorting	○
	Pulverizing	○
	Composting	◘
	Incineration	⊙
	Collection	○
E-Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	☒
	Collection	⊙
Healthcare Waste	Material Recovery	☒
	Sorting	☒
	Pulverizing	☒
	Incineration	●
	Collection	◘

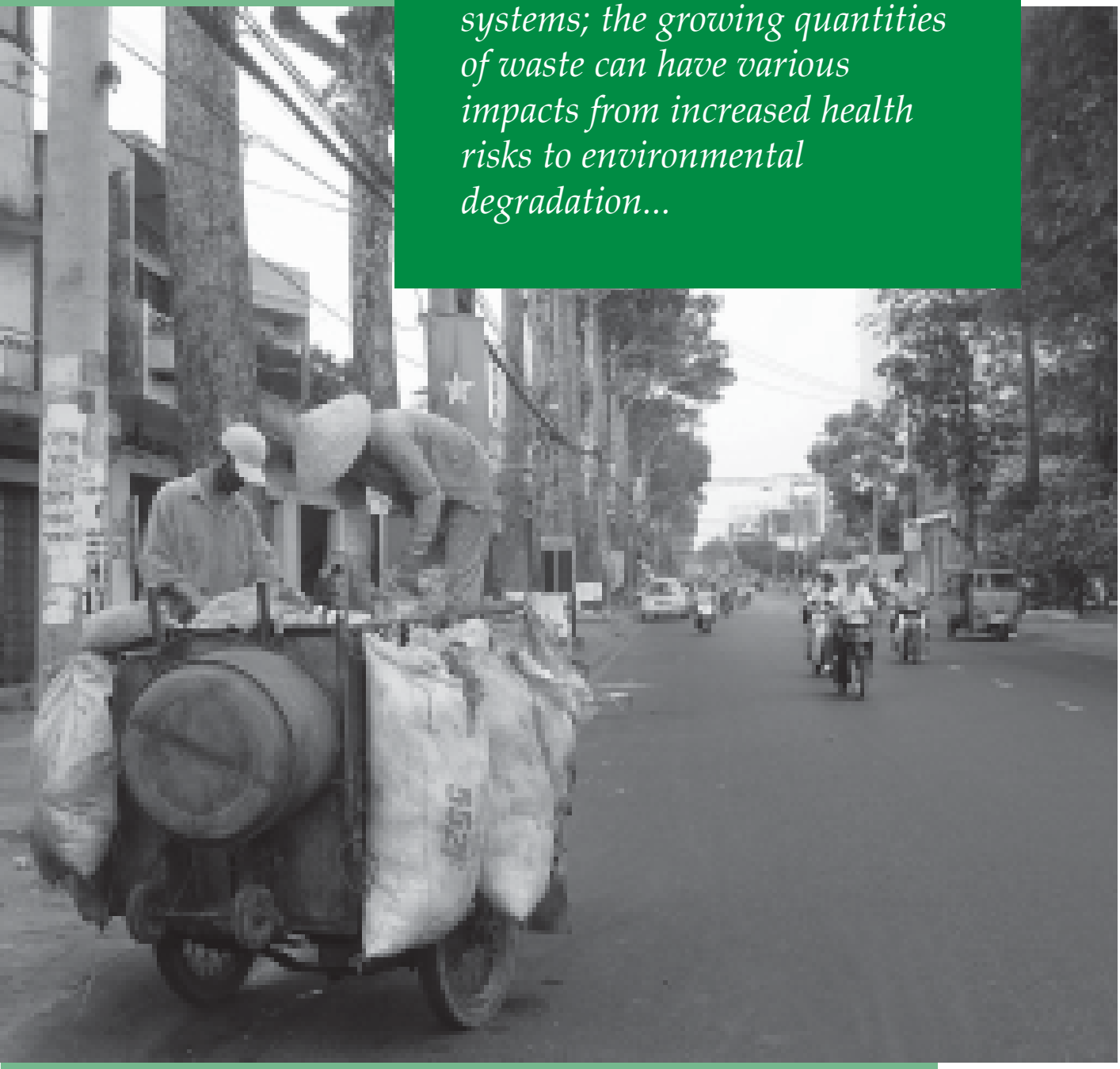
● Formal, Strong
◘ Formal but weak
⊙ Informal, Weak
○ Informal but Strong
☒ Technology Gap

CURRENT SITUATION OF NATIONAL POLICIES, LEGISLATIVE MEASURES AND OTHER INITIATIVES

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	National Strategy for Environmental Protection Sets targets for 2010 and 2010	○
	Direct Regulatory	• Provincial Cleaner Production Action Plan • National Cleaner Production Program • Green Aid Plan	○
	Economic	Preferential Taxation Financial & Technical Support by Switzerland, Japan & Canada	○
	Voluntary	Vietnam Cleaner Production Center (VNCPC) Vietnam Productivity Center (VPC) Promotion of Environmentally Friendly Industries	○
	Information	National Cleaner Production Program	○
	Procedural	Lack of Systems for Environmental Quality Surveillance	○
Support for 3R-related Activities		• Financial support by Swiss Government • Financial and Technical support by Government of Japan and Canada • Support from Japan International Cooperation Agency (JICA) • Asian Development Bank (ADB) • United Nations Centre for Regional Development (UNCRD)	●
Environmental Education		Lack of environmental education	☒
Science and Technology		Promotion of clean technologies	○
Reduction of Barriers to International Flow		• Law on Environment Protection • Import and Export of scrap materials • Signatory to Basel Convention	●
International Cooperation		Cooperation with Swiss Government Information sharing, Training, Public Awareness • Green Aid Plan: Vietnam - Japan Cooperative Plan • Vietnam - Canada Environmental Project National 3R Strategy Development • JICA • ADB • UNCRD National Legal Framework, Policy and Strategy • 3R National Strategy Formulation (UNCRD) Pilot Projects: • Reduce: National Cleaner Production Center (UNIDO/ UNEP) • Recycling: Economic Incentives through - Making Waste Work for the Economy (CIDA) • Source Separation and Composting of Municipal Waste Work for the Economy (AUSAID)	●
Cooperation of Stakeholders		• Adoption of Cleaner Production • Cooperation within local industries, communities and Governments, other agencies and Asian countries	○
Promotion of Science and Technology for 3R		• National Cleaner Production Action Plan (NCPAP) • Initiating Technology Development • Composting Technologies • Technology for Composting Organic Waste with Sludge	○

● Sufficient ○ Insufficient ☒ Gap

Vietnam's solid waste management needs are substantial in relation to existing capacity and the continued growth of urban areas and industrial development. Without undertaking the necessary measures to establish effective handling, treatment, and disposal systems; the growing quantities of waste can have various impacts from increased health risks to environmental degradation...



From the findings, though there have been successful practices such as thermal, fuel and material recovery was observed, there is still a lack of environment friendly technologies exists. For instance, incineration is one of the technologies highly practiced where problems with dioxin emissions and disposal are still persistent. Instead of finding adhoc solutions for waste management, strategic plans on choosing unobserved environmental friendly technologies practiced at smaller level has to be brought to the limelight and made as a reference...

chapter 4

Conclusions & Recommendations

A review of prevailing waste management practices and technology gaps towards implementing 3R was conducted for some Asian countries. The scope of the study was restricted primarily to three sectors: urban municipal waste, healthcare waste and e-waste. The following sections provide a comprehensive interpretation of the results.

URBAN MUNICIPALWASTE

An analysis of urban municipal waste management indicates that 3R-oriented technologies such as thermal recovery (direct combustion of waste to recover heat) and fuel recovery (production of refuse-derived fuel and packaging-derived fuel from waste) are effectively practiced in Japan, Singapore, Korea, India and Malaysia. Technologies such as incineration are formally strong in Korea, China, Malaysia and Thailand. It was observed that successful countries with better technologies have adequate management and policy instruments. In countries like Cambodia and Vietnam, technologies for material recovery, sorting and pulverizing were found to be informal but strongly practiced. Remarkable technology gaps were found in Bhutan followed by Cambodia due to insufficient national policies, barriers to access international information, technology and services, and insufficient international cooperation.

HEALTHCARE WASTE

Among the 3R-based technologies for healthcare waste, incineration was observed to be predominant in countries such as Japan, Singapore, China, Korea, Malaysia and Thailand. Waste-to-energy technologies for recovering thermal, fuel and materials were found to be practiced strongly in Singapore, Korea and Malaysia. In India, although various technologies are practiced, they are often observed to be informal, but strongly deployed. This is due to the inadequate policies and management system. On the other hand, countries like Philippines, though having appropriate policies and essential instruments, lack cooperation and good practices. Vietnam and Bhutan are among the countries showing insufficient management systems and policy aspects.

E-WASTE

In the case of e-waste, Japan was found to have formal and strong technologies like material recovery, sorting and pulverization. Next are Korea and Thailand with successful practices in material recovery and sorting. Among the other countries, Cambodia was observed to be informal but with strong practices. Countries such as Bangladesh and China were found to have largely informal and weak systems. This can be attributed to the insufficient management and policy frameworks.

In essence, an overview of the current practices of waste management indicates that:

- Recycling is predominantly in the informal sector and uses primitive technology.
- Very little instances of promoting formal, 3R-based solutions for waste crisis exist.
- Specific policies emphasizing the need for 3R are very rare in Asian countries with exceptions of some developed nations in the region.
- Technology Transfer and Policy Reformulation are essential to promote 3Rs.
- Cooperative and concerted efforts between and within countries are at the hour of need to promote a 3R-based economy.

RECOMMENDATIONS

The current practices in all the countries studied, in one way or the other, are left with insufficient technologies. This can be attributed to two possible reasons: appropriate enforcing policies and better management systems to have control over the technologies for waste management. Only one country, Japan, is observed to have fulfilled almost all the aspects. As a matter of fact, the experiences gained and lessons learnt by Japan with technologies can be utilized by the other countries that are lagging far behind. Practices in developing countries like Japan, Singapore and Korea can be considered as an example or benchmark to reach the goal instead of starting from scratch. The identified gaps can be filled up by adopting technologies that are found to be predominantly successful in other countries depending on their applicability, generation rate and composition. Cost-effective and environment friendly technologies (e.g. waste-to-energy) are found to be the focus in developed countries than developing countries. Developing countries using technology as solutions for their waste, but with the impacts on environment can trail or seek technology transfer from the developed or any other successful countries.

From the findings, though there have been successful practices such as thermal, fuel and material recovery was observed, there is still a lack of environment friendly technologies exists. For instance, incineration is one of the technologies highly practiced where problems with dioxin emissions and disposal are still persistent. Instead of finding adhoc solutions for waste management, strategic plans on choosing unobserved environmental friendly technologies practiced at smaller level has to be brought to limelight and made as a reference. Beginning from source segregation, acceptable technologies found in other countries can be followed in receipt of knowledge / technology transfer from them.

Existing technology practices are not found to be sufficient to overcome the burden of waste in a sustainable manner. Simple technologies for 3R have to be made formal and strong by promoting new policies, reformulation of existing policies, cooperative efforts and technology transfer. Thus, the technologies chosen for waste management have to be evaluated for their sustainability, in addition to being environmentally effective, economically affordable and socially acceptable. Filling the gaps with such a design is highly indispensable for all the countries to reach the goal of a sound material-cycle society. In this endeavor: 3R technologies associated with MSW sorting, pulverization and composting have to be followed. Technologies like composting have proved to be one of the best affordable solutions for developing countries to manage their municipal waste.

Further enhancement of current efforts is recommended for managing e-waste where policymakers and the industries join in implementing cleaner production mechanisms and enforce Extended Producer Responsibility. Source segregation of healthcare waste is vital in Asia for 3R implementation and management.

To boost such initiatives and to solve the medical waste management dilemma, trained personnel at healthcare organizations are required to facilitate the appropriate management of the waste. An ideal example would be the 'medical waste supervisor' as suggested by Dr. Satoshi Imamura of the Japan Medical Association.

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Reduce, Reuse, Recycle

About 3R Knowledge Hub

Alarming increases in resource consumption and waste generation are evident across the world and warrant the move towards a sound material cycle society. Reduce, Reuse, and Recycle; the 3Rs of waste management are the buzzwords of the present day world in tackling the resource and waste crisis.

The 3R Knowledge Hub (3RKH) is a joint initiative of the Asian Development Bank, the United Nations Economic and Social Commission for Asia and the Pacific, the UNEP Regional Resource Centre for Asia and the Pacific and the Asian Institute of Technology. The foremost function of 3RKH is to create, collect and capture 3R information and storing it in an easily retrievable platform, in addition to sharing, enriching and disseminating it. The hub functions are hosted and operated jointly by UNEP Regional Resource Centre for Asia and the Pacific and the Asian Institute of Technology, in collaboration with other relevant partners.

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