

# RDD

Regional Development Dialogue

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## 3Rs AND ENVIRONMENTALLY SOUND MANAGEMENT OF WASTE FOR ACHIEVING SUSTAINABLE CITIES

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Regional Development  
Nagoya, Japan



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## Editorial Introduction

A. S. F. Chiu

This issue of *Regional Development Dialogue (RDD)* primarily tackles key ideas about the urbanization of cities and how to effectively make them sustainable in terms of waste management. Research was undertaken with regards to environmental policies and waste management techniques that can be used to meet the regional challenges towards 3R and the sustainable management of wastes produced by cities. This issue contains eleven articles covering the implementation of 3R, green productivity, life cycle analysis (LCA), Cleaner Production (CP) technologies and management, eco-design, and eco-industrial development. These articles were further applied in the context of municipal waste, e-waste, and landfills.

### Introduction

Cities are considered one of the most important battlefields as they constitute a higher concentration of population, economic activities, and material and energy consumption. Cities cover only 2 per cent of the earth's surface, yet consume 75 per cent of all resources and produce 75 per cent of all waste.<sup>1</sup> Over the years, cities have rapidly urbanized as they developed and coupled with this is the rapid increase of waste generation. Waste generation has increased exponentially along with improvements in the economic situation of the population, reflecting the materialistic nature of society.

It is deemed that sustainable urbanization of fast-growing cities requires a balance between economic, environmental, socio-political, and technological aspects.<sup>2</sup> Achieving this balance, in turn, requires a combination of strategic policy making by cities, supported by a system that combines personal opinion with scientific knowledge.<sup>3</sup> Each of these aspects has its importance; however, this *RDD* issue will only focus on the environmental aspect towards sustainable cities. As such, waste management policies, urban metabolism, strategic plans, and waste management systems will be the main focus of concern.

Specifically, the achievement of sustainable cities is seen to be in the realm of 3R at the cradle stage and environmentally sound management of wastes at the grave stage. Modern paradigm has also integrated the cradle-to-cradle approach, wherein 3R, circular economy, and closed-loop mate-

rial flow became synonymous. The 3R Initiative aims to prioritize 3R policies and improve resource productivity, establish an international sound material-cycle society, and collaborate for 3R capacity development in developing countries.<sup>4</sup> The basic principles of the Initiative call for “the realization of a society in which sustainable development is possible with less environmental impact; prioritization of handling products, wastes and recyclables; and ensuring appropriate material cycle in nature”.<sup>5</sup>

This issue of *RDD* aims at promoting successful strategies and policies based on sound scientific ground to meet regional challenges towards 3R and the sustainable management of wastes produced by cities.

## **Key Issues and Challenges for Achieving Sustainable Cities**

**Sustainability and waste management.** Orderly waste management has extensive effects on overall sustainable development, especially in relation to ecological sustainability which refers to the separate collection and sorting of wastes, in addition to recycling and reusing. These, in turn, decrease the need for new resources, and cut down the amount of land needed for landfills as well as the amount of fossil energy if waste is used for energy production. Effective waste management also includes the repair of damage, which has occurred in the past. Current approaches to sustainable waste management stress this ecological component and also take into account economic aspects. These approaches are usually referred to as integrated waste management systems. They deal with all types and all sources of solid wastes, including waste collection and sorting, and any form of recovery, treatment or landfilling. As for the sustainability of integrated waste management systems, the:

Total Quality objective would be to minimize the environmental burdens of the whole waste management system, whilst keeping the economic costs to an acceptable level...An integrated approach to solid waste management can deliver both environmental and economic sustainability.<sup>6</sup>

Yet, the objective of comprehensive sustainable waste management is to “deal with society’s waste in a way that is environmentally efficient, economically affordable and socially acceptable”.<sup>7</sup> In accounting for social problems, waste management can assume responsibility for the society it is working for. As such, a more holistic output could be achieved under the three pillars of sustainable development when economic, ecological, and social factors are studied in connection.

**Informal waste sector.** Several publications have cited the significant roles of the informal sector in waste management.<sup>8</sup> But it seems that there is a lack of attention by governments to improve the living conditions of this sector and to protect them from hazards and harassment while carrying out this activity. In some countries, the condition of the informal sector remains unchanged and they have continued to live in poverty. They continue to operate under unstable conditions, wherein their income is dependent on the prices of recyclables and their activities are often repressed by government regulations. As a result of the economic crisis that had world-wide repercussions, this sector has also been greatly affected as the prices of recyclables were reduced by more than 50 per cent,<sup>9</sup> and thus their income, too. In addition, as their activities are often considered unregulated, they are prone to being harassed by the authorities, middlemen, and even community. Despite their significant contribution to the reduction of solid waste, especially in the urban city, they are often not given due recognition as their “technology” is considered backward and they are thought incapable of doing the job due to lack of



education and technical skills. To some extent, they are considered a nuisance to development and their operation is considered to have hazardous effects both on the environment and human health. Due to extreme poverty and lack of other available options to them, they continue to engage in this kind of job despite the unsafe working environment.

Industrial ecology in its evolution has introduced two important branches; namely, eco-industrial development and urban metabolism. Eco-industrial development has a long history as traced back to European cases such as the Kalundborg<sup>10</sup> and Asia's Quigang.<sup>11</sup> Modern development in this field has evolved from pure industrial symbiosis to industrial-urban development, as depicted in the case of Kawasaki.<sup>12</sup>

Urban metabolism has also evolved in the scientific community. The Sustainable Urban Systems section of the International Society for Industrial Ecology (ISIE) is concerned with applying methods of industrial ecology towards the sustainable development of cities, their supporting hinterlands, and the networked infrastructure that connects them. Practical solutions to these issues are informed through the study of urban ecology, urban metabolism, and dynamics of city growth.

**Measuring life cycle effects and holistic analysis in waste management.** Waste management and LCA are connected in a threefold way: first of all, every life cycle ends with at least some part of a product or process producing waste. Second, waste management activities should undergo LCA themselves. And finally, the reusing or recycling of waste can initiate new life cycles that should be measured.<sup>13</sup> In their Thematic Strategy on the Prevention and Recycling of Waste, even the European Commission (EC)<sup>14</sup> explicitly encourages the application of life cycle thinking to waste management under the Waste Framework Directive.<sup>15</sup> Still, up to now, the focus has mainly been on “reducing the negative environmental impact of waste generation and management and to contribute to an overall reduction of the environmental impact of the use of resources”.<sup>16</sup>

### **Overview of Contributions to this Issue**

(1) “Crossroads between Resource Recovery and Industrial Symbiosis Networks — Evidence from Case Studies”: Inês dos Santos Costa and Paulo Ferrão identified interactions between resource recovery and industrial symbiosis networks, which are two operational strategies that contribute to ecosystem sustainability. The study further discussed the nature of these intersections and how they can improve the material loop-closing performance of industrial systems. In this study, a case study methodology was applied involving: (a) a multiple case study analysis of IS networks in various countries; (b) a case study at the regional level, using waste exchange data from industries within the urban metropolitan area of Lisbon, Portugal; and (c) a case study at the local level, in an eco-industrial park in Chamusca, also in Portugal. The results document that: (a) resource recovery (RR) companies can be active participants in IS networks; (b) RR and IS network activities could be complementary and assist each other; and (c) RR companies can foster symbiotic relations between themselves and generate further symbiotic relations with other manufacturers.

(2) “Municipal Waste Management in Metropolitan Manila, Philippines: The Role of the City and the Informal Waste Sector in Mitigating Climate Change”: In the process of improving disposal facilities, the participation of the informal waste sector is crucial for solving the social weight of climate change. Kevin Roy B. Serrona and Jeong-soo

Yu investigated the interplay of local players in mitigating climate change in the waste sector and emerging co-benefits. The authors used the case of Manila, the Philippines to discuss the issue of municipal waste management.

The study documented that the integration of disposal facility development and community participation is feasible in the context of communities where the local government unit (LGU) is proactive in addressing environmental and social concerns. Moreover, emerging co-benefits from sound waste management and active community participation include: the practice of recycling that paves the way for reduced expenses in waste disposal; prolong use of a disposal facility through waste diversion; energy security by WTE development, which means less dependency on foreign oil suppliers and thus reducing greenhouse gas (GHG) emissions; and the involvement of the informal waste sector, which affirms the trust of the community towards the LGU, a manifestation of giving recognition to local capacities in economic development.

(3) “The Economics of 3R in Generating Real Employment in the Philippines”: Increasing waste generation prompted various management approaches, including efforts to perform CP, eco-efficiency or green productivity, and even sustainable consumption and production. Simple, yet challenging, ways have also been proposed such as the 3R Initiative by former Japanese prime minister Koizumi which focused on capacity-building in Asia. In the Philippines, various responses from the national government as well as from all LGUs that geared towards real and unreal solutions have been made. External funding and assistance proved to be important catalysts in realizing waste management initiatives, particularly in terms of waste diversion and recycling. In their article, A. S. F. Chiu, Christine Anne Cabiles, Tarin Jenelle Tee, and Antonio Louis Holmes investigated the extent of potential decent employment that can be generated from undertaking close-loop reduce-reuse-recycling activities or 3R-related activities in the Philippines in general. The four local cases on waste management and 3R implementation presented illustrate basic responses of the local governments to waste management. Economic benefits from projects are seen to sustain implementation of these initiatives. Based on these cases, suggestions were drawn on how to strengthen policies in support of green business and employment.

(4) “Benefits and Strategy to Improve the Condition of the Informal Sector in Waste Management”: Vella Atienza investigated the working conditions of the informal sector whose primary source of living is the scavenging, buying, and selling of waste with the aim of outlining the strategies for improvement and benefits that can be realized from such improvement. Cases from the Philippines and Southeast Asian countries were used to illustrate the positive impacts of recognizing the important roles of this sector in waste management, and the benefits of providing support to upgrade their recycling operations. By making a comparative analysis of the salient features, the effectiveness, sustainability, and replicability of possible strategies showed that each has its own benefits of forming the informal sector into an organization/cooperative and upgrading their recycling operation, but they are conditional on both financial and technical support from the government and other stakeholders. The benefits outlined extend through the informal recyclers, municipality concerned, and to the environment. Policy recommendations were also delineated for properly and regulated waste management processes to maximize the potential livelihood opportunities and environmental benefits.

(5) “Environmentally Sound e-Waste Recycling in India: Mainstreaming the Informal Sector into the Formal Recycling System”: Electrical and electronic waste (e-waste) is

one of the fastest-growing waste streams in the world, as documented in the literature review conducted. The study reveals that only about 6 per cent of e-waste is recycled, of which 95 per cent is recycled through the informal sector. The investigations of Rachna Arora, Ashish Chaturvedi, and Ulrike Kilguss showed that the existence of an informal, but entrepreneurial, small- and medium-sized enterprise (SME)-based infrastructure permits a profitable e-waste management business. At the same time, the informal sector lacks skills and technologies, and manages potentially hazardous material in an environment-risky manner without any regard to occupational health and safety (OH&S) requirements. It is observed that with rising e-waste quantities, the recycling scenario is changing with the formal recyclers entering the e-waste recycling sector. There is widespread expectation that these formal sector recyclers would manage e-waste in an environmentally sound manner by using best available technologies (BATs). However, it is not clear whether the advent of formal recycling would come at the expense of the informal sector recycler or would complement their activities.

In their article, the authors presented a model which allows the integration of the informal and formal sectors in India. The broad building blocks are: (a) federating disparate informal sector workers into collectives; (b) capacity-building at various stages of the e-waste value chain; (c) development of appropriate framework conditions in support of the informal sector; (d) elaboration of applicable business structures taking into account the constraints and resources of the informal and formal sectors; and (e) implementation, monitoring, and evaluation of the model in different baseline situations. These options have been developed, implemented, and evaluated in the framework of different Indian, EC, and bilaterally-financed studies and projects focusing on Delhi, Bangalore, Pune, and Kolkata.

(6) “Dealing with Electrical and Electronic Equipment Waste in Colombia: The Case of TV Sets”: Luz Angélica Rodríguez B., Enrique Estupiñan E., and Frank Boons analysed the specific context of waste of electrical and electronic equipment (WEEE) in Colombia, focusing on TV sets. In Colombia, consumption of electrical and electronic products is increasing, but consumption patterns differ from developed countries due to socio-economic and cultural conditions. Those conditions make the reuse as well as storage of products a predominant practice. In this article, the authors addressed the issue of how socioeconomic conditions influence the shaping of a system to deal with WEEE.

The study draws on existing literature to uncover possible conditions, and then present the results of an empirical study focusing on consumer behaviour, including a survey among the population of Bogotá, Colombia’s capital city. This study focuses on TV sets, electrical and electronic equipment (EEE) with the highest penetration in Colombian households, and allows us to evaluate consumer behaviour in the different socioeconomic strata. Based on the analysis of consumer behaviour conducted, the study contributed to establishing recycling and reuse rates, and the determining appropriate operation conditions of a WEEE system for the region.

(7) “The Influence of the Waste Hierarchy in Shaping European Waste Management: The Case of Plastic Waste”: David Lazarevic, Nicolas Buclet, and Nils Brandt reviewed the role of the waste hierarchy in European plastic waste management, its implementation through different political objectives, and effect of these objectives on plastic waste management, in the context of European harmonization. Considering three European countries, namely, Germany, France, and the UK, the study presented the countries’

problems in dealing with plastic waste management and showed diversity in technological and institutional approaches to waste management. Moreover, the analysis focused on two plastic waste streams, plastic packaging waste and plastics from household waste, as they are the largest streams and have been the focus of European harmonization.

The research shows waste hierarchy as being a salient factor in the establishment of political objectives such as the establishment of prevention, reuse, and recycling targets. From a European perspective, actors adhering to the concept of life cycle thinking have renewed debate over its legitimacy as a principle of waste management. More so, it has been shown in the case of plastic waste that no reliable conclusion is available. Rather than the rationalization of decisions, the authors considered the holistic nature of the life cycle approach, which allows an understanding of the main areas of environmental importance during the end-of-life phase of products, as its greatest benefit. The authors purported that it might help to understand in which direction conventional regimes and their embedded principles should evolve in order to improve waste management.

(8) “Applying Life Cycle-Oriented Tools for Analysing the Sustainability of a Regional Waste Management System”: Even a sophisticated waste management system has extensive positive and negative effects on society and nature, which must be measured and deliberated. Despite attempts to measure the ecological sustainability of waste management by assessing the ecological effects throughout waste life cycles, the social effects of waste management activities have never really been paid much attention to. Ulrike Gelbmann and Hannes Klampfl-Pernold presented an instrument directed at analysing the overall sustainability of a regional waste management system from a triple-bottom-line perspective, focusing on social effects. The method is based on a Grounded Theory approach and blends waste life cycle assessment tools and elaborate criteria for measuring sustainability. Applying the approach to the Austrian region of Styria’s waste management system aimed to provide evidence on applicability.

As a result, this study modified the concept of “Product Line Analysis” which measures life cycle effects of products as to ecological, economic, and social impacts. A method was obtained that does not comprise a life cycle assessment approach in conventional terms, but focuses on the general conditions of the regional waste system and discloses the possibilities for triggering and fostering sustainable behaviour of both enterprises and citizens. Practical application depicts shortcomings and room for improvement as to the social and societal aspects of waste management while, at the same time, also being responsive to ecological and economic aspects.

(9) “Industrial Ecology Looks at Landfills from Another Perspective”: The objective of the study by Leenard Baas, Joakim Krook, Mats Eklund, and Niclas Svensson is to go beyond the currently established view on landfills as final deposits for waste and analyse their potential as future resource reservoirs. The authors analysed whether the application of the industrial ecology concept can contribute towards realizing the approach of landfill mining as an alternative strategy for extraction of valuable material and energy resources. In doing so, an analytical approach involving three main steps was applied. Firstly, state-of-the-art research on landfill mining is reviewed in order to identify critical barriers for why this promising approach has not yet been fully realized. Then, some of the main constituents of industrial ecology research were briefly summarized with special emphasis on how they relate to landfills. The third and final step involved a synthesis aiming to conclude in what way industrial ecology could contribute

towards addressing the identified challenges for landfill mining implementation. The study concluded that the systems view of industrial ecology provides both a comprehensive view on environmental potential and impacts as well as new public/private partnerships for landfill mining activities for mutual benefits.

(10) “Promoting Urban Organic Waste Utilization in Developing Asian Countries: Case Studies in Cambodia and Thailand”: This article by Janya Sang-Arun, Magnus Bengtsson, Alice Sharp, and Chan Kim Heng reviews the current status of urban solid waste management in Cambodia and Thailand, and describes three urban organic waste utilization projects based on composting and anaerobic digestion. The multiple benefits of these three case studies are analysed, including the effects on solid waste management, agriculture and food production, energy, employment, and climate change mitigation. In addition, the article identified major challenges and key factors for more widespread use of composting and anaerobic digestion in the study countries. Finally, the article made a number of policy recommendations on how to promote extension of organic waste utilization practices and to enhance benefits sharing among stakeholders.

(11) “3R as the Basis for Sustainable Waste Management and Resource Efficiency”: Robert Berry and C. R. C. Mohanty, in their article, stated that countries not only face solid waste management issues, but also face significant challenges in terms of resource efficiency concerning both water and energy. These lead to further environmental problems and even international conflicts. The authors suggest that 3R can be applied to all stages of the waste management cycle, and places emphasis on the reduction of waste first and foremost, and then subsequently its reuse and recycling. While 3R is commonly associated with solid waste, it can furthermore be applied to a range of sectors such as agriculture, industry, water, energy, among others. The authors pointed out an important issue that solid waste generation is associated very closely with other types of resource exploitation.

Each country faces its own unique set of challenges, and thus there is no standard model of waste management and resource efficiency that can be applied for all cases. However, the authors provided general conclusions and recommendations which include: (a) legislation and its enforcement on the part of the government are key features of a sustainable waste management system and resource efficiency; (b) incorporating capacity-building measures for stakeholders into information-based measures is important; (c) responsibility, of course, does not lay only with the government; (d) waste management should also consider the local context; (e) incorporating all stakeholders is the basis of an integrated system; and (f) incorporating all stakeholders in contributing to efforts in waste management and resource efficiency should be on a global scale.

### Concluding Notes

This *RDD* issue started with the noble vision of serving as a regional development reference reflecting the current status and foreseen scenario on the issue of 3R’s role in urban waste management. We also attempted to examine the issue of sustainability and focus more on the ecological dimension. As the authors of the eleven articles expressed in their views, their synthesis concluded that there is a need to take a step backward and look at the issue holistically as a system.

**Holistic system as in life cycle is concerned.** The product life cycle from its cradle to grave has been studied in the eve of the century, and waste management found ways to extend a product’s life for reuse, recycle, and remanufacture. This noble idea extended

the one-cycle life cycle mindset to multi-cycle cradle-to-cradle mindset. As many authors on LCA and industrial symbiosis assess the contribution (positive) and impact (negative) of products' life cycles over this temporal dimension, the overall optimum product value is still very much constrained by the technology. This is well evidenced by the down-cycling nature of the resources in its recycling process. Eco-town in Japan and many new initiatives around the world to close the resource loop have had been working hard to achieve the true loop-closing objective by R&D efforts on up-cycling.

**Holistic system as in triple-bottom-line is concerned.** This issue wished to focus on the ecological dimension, and yet waste management is also resource management. Resources are assets that give value to economic and social interests. When waste is appropriately used at the right place and time, waste is a resource. The equation will shift from cost minimization to profit maximization from the system management point of view. Having said that, optimization of value to the constituents in a political system such as an urban city is the optimal goal of the government. There is a need to find a tool that measures and gives baseline data for politicians to craft policy, and many authors pointed out that the social dimension has been marginalized in many earlier works. There is a need to internalize the three pillars of sustainability, and integrate all the externality costs into the equation. Stakeholders from the different sectors many play the leading role in different economies to compensate the marginalized sector if social cost is wholly integrated into the cost-benefit analysis (CBA) of the system. This concept is extremely important as discussed in many papers on the informal sector involved in municipal solid waste management, wherein compensation is not sufficient for social development of this sector.

**Holistic system as in boundary is concerned.** The articles on the urban city and symbiosis have depicted cases over and over again that a perfect industry mix, or waste stream mix, can lead to the ideal loop-closing scenario. While the ideal mix is somewhat theoretically easy to attain, in reality only near optimal mix is attainable. Building a brand new symbiotic boundary may take the shape on a two-pronged industrial park, or larger scale such as a city, or even larger scale that covers the entire region of Styria. Discussion in the academic world on either symbiotic scenario can be planned or uncovered taking into consideration the local scenario, conditions, and resource abundancy, among others. Berry and Mohanty's concluding article made a very great contribution to this issue by summarizing the generic policy and action programme needed to be prioritized from economies to economies.

## NOTES

- \* The guest editor is grateful for the assistance from the Graduate School of Engineering of De La Salle University led by its graduate researchers; namely, V. J. Cantor, T. Tee, C. Cables, N. Felix, A. Abad, S. Sumang, F. Tañala, L. Tumlos, I. Barilea, and J. Kang. Also, the guest editor wishes to thank the authors of all articles and comments for both their work and patience for the time taken to finalize this issue.
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