Reforming Municipal Solid Waste Management in Indonesia Using Market Instruments: Applying a Co-Benefit Approach in Green Economy Paradigm for an Emerging Economic Country

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Abstract

In recent years Indonesia has been confronted with an excessive generation of municipal solid waste (MSW), predominantly present in the form of organic refuse. While moving towards integrated solid waste management (ISWM) is an important strategy used to control its generation, it is also now recognized that economic approaches need to be promoted as well in order to tackle the problem concertedly. In this case study, empirical approaches are developed to understand how market instruments could be introduced into environmental services and how to apply a co-benefit approach in a green economy paradigm for Indonesia. We investigate the feasibility of introducing market instruments in Indonesia by applying local co-benefit initiatives adapted from German experiences in integrating market instruments into MSW management practices. Currently co-benefit activities are undertaken in the Sukunan village (Yogjakarta) to promote waste composting using market incentives in the framework of community-based solid waste management (CBSWM). This scheme aims at reducing MSW generation at its source and mobilizing people to be involved in waste separation (organic and non-organic) at household levels. As a result, about 200,000 t of CO2 emissions could be successfully reduced annually. By integrating market instruments into waste management practices, the result of our studies suggests that Indonesia could make positive changes to its environmental policy and regulation of MSW at local levels. The country's policymakers have played important roles in promoting the effectiveness of urban development with co-benefits approaches to facilitate its transition towards a green economy.

Keywords: Co-benefits approach; Emerging market; Germany; Green Economy; Market instrument; Municipal Solid waste

Highlights:

1. Indonesia has successfully drawn valuable lessons from German capacity in MSW management;
2. Integrated solid waste management and market instruments could control MSW generation in the Sukunan village (Yogjakarta);
3. Co-benefit approaches have facilitated environmental protection in Indonesia towards a green economy.

1. Introduction

As one of the world's emerging economic countries, Indonesia has been confronted with MSW problems recently. With an area of 1.92 million km2, as of 2013 Indonesia was home to about 240 million of inhabitants, accounting for 3.5% of the world's population. Currently Indonesia generates MSW about 45.5 Mt/y (Aprilia et al., 2010). Unlike homogeneous waste streams that originate from industrial or agricultural activities, MSW characteristics are complex (Sakai et al., 1996). The waste includes not only refuse from households, which is very predominant, but also non-hazardous waste from industrial and institutional establishments (Hoornweg and Tata, 2012).

On average, around 384 cities in Indonesia generate about 2.48 to 3.27 kg per capita daily. With an annual population growth of 2.4%, it is anticipated by the country's environmental agency that the amount of MSW generated in Indonesia will reach one and half times higher by the end of 2020 (Chaerul et al., 2007). The significant increase in the magnitude and the complexity of the generated MSW reflects the challenges that the government needs to deal at both local and national levels (UNEP, 2004).

In Indonesia, the MSW consists of organic waste, paper, and glass (Aprilia et al., 2010). The refuse is classified either as residential or non-residential waste. Sixty percent of residential waste (by weight) consists of degradable organic materials, while the amount of degradable organic materials in non residential waste varies depending on its moisture content. The characteristics of MSW in Indonesia are presented in Table 1 (Trihadiningrum, 2006).

Yulinawati (2005) estimated that the MSW industry in Indonesia would contribute about 15% of the total greenhouse gases (GHG) emissions for the next century. Unless properly tackled, the country would face serious urban environmental degradation that beyond its capacity to absorb the volume of MSW generated. Consequently, the local MSWM could not meet the demand for its proper disposal, thus causing a backlog of MSW left in the urban environment.

In the long-term, this situation will derail the country's progress towards the UN Millennium Development Goal (MDG) and hold back its development towards environmental sustainability. However, if well managed, proper waste management could benefit its stakeholders through waste avoidance, resources recovery and net reduction of GHG emissions (Meidiana and Gamze, 2010). Therefore, seminal approaches for MSWM that

includes collection, treatment, and disposal are required. A high quality of MSWM improves economic efficiency and addresses environmental deterioration caused by resource shortages, thus facilitating sustainable development (ADB, 2006). If the MSW growth could be reserved by tackling it from upstream to downstream, this would facilitate its resource recovery on sustainable paths (McDougall et al., 2009).

To attain a green economy, development strategies need to go beyond engineering aspects (Kurniawan et al., 2011). For this purpose, the waste has to be recycled in a way that creates added value and sustainable jobs for community. By turning unused waste into resources with an added value (Babel and Kurniawan, 2003), environmental gains in terms of indirect reduction of GHG emissions may be attained by decoupling economic growth from resources consumption or through offsetting the direct GHG emissions from GHG savings (IGES, 2009). An increasing waste generation due to an inefficient use of resources often accompanies economic growth (Sjöström and Östblom, 2010). To achieve sustainable development goals, their link has to be broken. Santosa (2000) argued that the Agenda 21 would promote an effective use of market instruments to control environmental pollution and to alter people's behaviors through price mechanisms (Table 2).

The recent introduction of a Green Economy paradigm in the 2012 Rio+20 Conference has facilitated MSW problems to be tackled using various ways at the local level to bring an impact on a global scale. This empirical study is underpinned by a school of thought, which believes that both engineering solutions and economic approaches need to be promoted concertedly in order to tackle MSW problems. In this regard, market instruments could be applied to internalize the costs of waste management to enable its generators to bear the costs. Incorporating both engineering and economic approaches into local waste management practices would address three pillars of sustainable development and meets its objectives with respect to environmental, social and economic aspects, leading to sustainability in the long-term (Tahir et al., 2011).

In the context of the green economy paradigm, an improved waste management could facilitate green growth, resulting from waste avoidance, energy recovery and net reduction of GHG emissions. Therefore, an appropriate policy and regulation to harness socio-economic benefits from investing in waste management, would transform the waste sector into strategic roles: from being a comparatively minor source of GHG emissions (about 5% of the total anthropogenic emissions in 2005) to becoming its major net reducer; from being a part

of global environmental problems to being a part of seminal solutions in the path of sustainable development (Menikpura et al., 2013).

In addition, a proper waste management would enhance economic efficiency through resource recovery or waste prevention that represents a net saving of GHG emissions avoided from waste disposal. In the long-term, properly practiced MSWM would benefit public health and create job opportunities, thus paving a way for intragenerational equity. By applying this principle, the richer and the poor in the society share the costs and benefits of waste management.

A preliminary study undertaken by Kardono (2007) on MSW management in Jakarta mainly focused on integrated solid waste management (ISWM). In spite of its novelty, the study did not directly address the economic aspects of MSW. In addition, it did not adequately integrate economic instruments as a part of sustainability solutions in his study and the important links between the economy and the environment in the policy sphere were not well established.

To bridge and fill the existing research gaps in the body of knowledge, the empirical studies reported in this article investigates whether market instruments are technically feasible and applicable to reduce MSW generation in Indonesia and how co-benefit approaches would improve local environmental protection. Both positive and negative aspects pertaining to the adoption of market instruments in the context of co-benefits approaches are discussed. Through the lens of economics, this article also explores the implications of market instruments for MSWM practices in Indonesia towards a green economy.

In addition, this article highlights the importance of the green economy outcomes based on the Baden-Wüttemberg (BW)'s experiences in integrating market instruments into MSW management (MSWM) practices. As a key location of climate protec¬tion and adaptation to climate change, in recent decades Germany has been a role model for best practiced MSWM around the world. Other countries have drawn and applied valuable lessons from the country's capacity and successful experiences in this field. Among the 16 German States, BW was selected as a control case study due to certain peculiarities of its economy, as indicated by its extensive industrialization and rapid development that resembles aspects of emerging economies in countries like Indonesia.

2. Methodology

The methodology used in this research was one single case study in BW (Ragin and Beker, 1992). This study concerns with how market instruments such as waste disposal fees and deposit-refund system (DRS), which control MSW generation in BW, could be directly transferable and applicable to Indonesia. To undertake a thorough longitudinal case study, data were collected from primary and secondary sources. In the beginning, our literature survey focused on the analysis of written documents on Germany's pre-existing environmental policies concerning its MSWM. The documents were obtained from the local government in the BW state. These secondary data are complementary in this study.

In addition, data were derived from our semi-structured interview with relevant stakeholders in BW, such as government officials, technicians from local landfills, community leaders and local experts in waste. The activities of data collection were undertaken in July 2011 to facilitate this case-study. This method proved to be an effective way to find out what happened by asking critical questions and assessing on going phenomena with the stakeholders. The interviews took about 1 hour on average for each respondent. When necessary, interviewees were contacted again to address further questions. The interview was documented by using minutes of the meeting. The respondents' answers were screened to identify the most commonly discussed points. Their replies were also coded to detect key differences based on the authors' earlier surveys.

This method was preferable to distributing questionnaires, as it allowed flexibility and inspired the interviewers to ask additional questions during the interview based on the respondents' answers. As the data used in this research are mostly qualitative, they should be perceived as indicators only. This was due to the fact that this article does not supply information representing the whole situation in Germany, but rather presents material relevant to BW state as an example only. Similar method was used for data collection in the Sukunan village (Yogjakarta) to explore the feasibility and applicability of local co-benefit initiatives to control MSW generation in the context of CBSWM (Table 3).

A conceptual framework is proposed to address the research objectives mentioned previously (Figure 1). The framework justifies the lessons Indonesia need to draw from German's successful implementation of market instruments for its MSWM practices.

3. Results and Discussions

Although this article examines best practiced MSWM in one German state, BW is by no means the representative of the entire country. Since the authors' goal is to understand how effectively market instruments could be directly transferable and applicable to Indonesia, it was decided that an embedded case-study might have been the most appropriate method to address the research objectives. In line with this approach, the focus of this article was on investigating to what extent market instruments could be effective in controlling MSW generation at community levels.

3.1 Municipal Solid Waste Management Practices in Baden-Wüttemberg: A Case-study

Situated in the southwestern part of the country and to the east of the Upper Rhine, BW is the third largest of the 16 States in Germany. With an area of 35,742 km2 and a population of 10.7 million inhabitants, BW is demographically similar to Jakarta, the capital of Indonesia (Table 4). Due to this similarity and because it has successfully tackled its waste problems through environmentally-sound solutions, BW represents an ideal case study for Indonesia.

The complexity of waste in Germany has facilitated the development of a number of seminal policies when the country promotes sustainable production and consumption policy in dealing with its MSW problem. A new era began in the country's MSW management practices following the introduction of the Duales System Deutschland (DSD) in 1990 (Vehlow, 1996).

From the very beginning, the implementation of the DSD program in BW state involves stakeholders from both public and private sectors by facilitating mutual public-private partnerships (Levine and Sandra, 1994). The state provides waste collection and processing services for green bins, which are distributed to each household for individual collection of the light portion of packaging waste, while the private companies provide services to business enterprises. The state also collaborates with private companies in transferring bulky waste to drop-off facilities.

To comply with DSD requirements, manufacturers are required to recycle a certain quantity of their products. Instead of returning each bottle to its original manufacturer, an association

of local waste management companies, called DSD, is involved in waste collection for recycling in exchange for cash payments from the DSD. Afterwards, the DSD charges the manufacturers based on the type and quantity of the packaging used. The charges represent a marginal cost imposed by the DSD to collect and sort individual materials (Patel et al., 2000).

Germany recognizes the potential of using waste as a resource and tackled it at source to the end of life, aiming to interrupt and reverse its unwanted growth. By implementing DSD, Germany changed the waste management approach towards resource based on the "3R" concept (reduction, reuse and recycling). The 3R concept reduces operational costs related to waste disposal and secures resource supplies by maximizing the life cycle of waste materials, thus presenting a way forwarding Germany to a sustainable path (Gray, 1997).

All of the states in Germany have been required to institute a solid waste management (SWM) system that clearly identifies how, where, and by whom MSW is treated or recycled. In this regard, the level of government, type of institution, and mechanisms for enforcement involved depend on the type of policy instruments. The Law requires individual households to separate their MSW for recycling and reuse. While most of the MSW could have a second life, there is also possibility to have some materials left until the end of its life cycle. Therefore, the waste has to be reduced at its source by compressing the product, which leads to a significant reduction in the volume or the weight of the waste.

Like other states in Germany, the BW has an integrated waste management system in place that includes source reduction, recycling, composting, resource recovery, and landfill. The major components of the SWM system in the BW state include drop-off bins for separating paper and glass, and bulky waste; material collection; and waste-to-energy (WTE) facilities for composting and local landfills. The landfill facility has a capacity for receiving MSW about 0.24 Mt/y. The State also has developed a yard waste composting system and source separation, while incinerating its biodegradable waste for generating heat and power.

In addition, the BW's waste collection and disposal services were integrated into a separate entity that consisted of various departments within the state's administration. The entity, called the Entsorgungsbettiebe der Stadt BW (ESBW) has been involved in the collection of household waste and packaging materials (Zhang et al., 2010). Presently the facility is used to treat and screen sortable waste such as commercial and domestic refuse. After preliminary treatments, the rest of the waste is transferred to the WTE facilities for combustion with

energy recovery. By integrating collecting, separating, and composting, over the past years, the BW State has significantly increased the recycling rate of almost 50%, as much as 50,000 t of useful materials annually, while creating job opportunities for local community. The materials include recyclable items such as plastics, glass, paper, wood, and metals recovered from various waste streams and compost originating from organic waste. The collection service in the State enables source separation to provide an efficient waste stream, leading to sorting and composting facilities. The BW State has increased the number of collection bins to facilitate source separation of organic refuse. Ultimately, this improves the quality of compost as end-product generated by the WTE facilities.

Apart from the implementation of ISWM facilities, waste avoidance is another key element in public education campaign in BW. Since 1990, this component has been incorporated into the State's programs related to waste management. Therefore, local organizations similar to the Salvation Army in the US have been involved in promoting the reuse of bulky materials like furniture and E-waste. Apart from the existing call-in system, a separate pick-up program has been organized for bulky items. Other seminal aspects of the MSWM practices in BW include (1) the presence of extensive networks of drop-off boxes and curbside collection of paper waste in various areas in each city; (2) the establishment of a separate corporate entity to address its own waste management needs; and (3) the implementation of economic instruments for MSW disposal based on the volume of refuse.

According to Pearce (1998), environmental charges such as a waste disposal fee and a deposit-refund system (DRS) are commonly used to influence people's behaviors. This German system has adopted the unit-charge to fund MSW collection. Accordingly waste generators are charged incrementally based on pay-as-you-throw (PAYT) policies. Residents pay a certain fee for waste service according to the volume of the waste they generate. The program ties waste charge to the cost of collection and disposal, thus providing incentives on waste generators to reduce waste through changes in purchasing styles and reuse of containers.

Theoretically, the use of market instruments for environmental protection provides a way to attain cost savings, while simultaneously achieving environmental objectives (Pearce, 1998). Apart from providing direct economic benefits through an improved public health and reduced environmental impacts, a proper use of market instruments will shift cost away from the poor and general community to the richer ones, who usually generate more waste (Levine and Sandra, 1994). In this regard, Miranda (1993) argued that market instruments would

encourage waste generators at the household level to modify their behaviour on waste management. As the market instruments could fully reflect the “polluter pays” principle, they could consolidate the cost of environmental damages due to the over-generation of waste into a full fee. Therefore, a waste disposal fee could set a certain price tag for negative implications of environmental pollution and enforce waste generators to fully pay their price. The implementation of such a policy is fair, justifiable, and efficient, as it will provide the society economic incentives to generate less waste. More importantly, it is no longer necessary for the government to spend its public budget for waste management.

The incentive of waste disposal fee will make waste generators to reduce the amount of waste they generated through recycling. Setting the right price for products that have the potential to end up as waste and pricing waste management services are essential to promote market instruments as a part of waste management policy in Indonesia (Kurniawan et al., 2013). Empirical studies undertaken by Pearce (1998) found that a higher price per unit of waste could reduce demand for waste collection service. With the incentives of a lower waste disposal fee, households would decide to reduce waste, leading to changes in their consumption of packaged products. Market instruments could in turn promote manufacturers to alter their production pattern, thus reducing MSW generation in the long-term.

The State of BW charges households a waste fee according to the number and size of their trash bins, and the frequency of their waste collection service. Instead of paying a fixed monthly fee for collection, residents have to pay an amount in proportion to the quantity of the MSW they generated. The fee charged to households in Germany varies from one State to another, depending on the size of waste container. In BW, the annual basic charge for one 80 L of trash bin is €70.50 with additional €0.16 per kg of extra waste generated.

A fixed fee is charged on every reusable trash container, while a higher charge is applied to each non-reusable trash container collected (Vehlow, 1996). The authors argued that if the prices for waste management were concisely imposed on waste generators, they would promote environmental awareness and responsibility of waste management, and have incentives to modify their behaviors.

As a result, BW has made a remarkable achievement on waste management. MSW generation in the State has substantially decreased 62% from 3.12 Mt in 1996 to 1.18 Mt in 2009 (Federal Environmental Agency, 2011). This feat has been attained because the waste prevention

system in BW has been effective in facilitating the transfer of MSW for recycling and reuse. Consequently, the proportion of MSW recovered and recycled has escalated and less MSW was disposed of in the landfills. So far, the recovery rate of MSW in BW has been significantly improved from 50% in 2000 to 70% in 2007 (Figure 2). Therefore, if Indonesia switched from current waste disposal practices to an integrated system like the one in BW, it would solve major problems related to its existing waste management.

As evidenced by this case study, BW has made the right balance between environmental protection and economic growth. In BW, environmental protection is regarded not an obstacle, but a tangible contribution to sustainable development.

3.2 Promoting Market Instruments for Waste Management in Indonesia

Waste management in Indonesia is often handled in a fragmented and uncoordinated manner. Consequently, there is a growing need for both integrated approaches and investment in the waste sector to address sustainable development issues. Harnessing investment capacity and technical know-how of private sectors such as manufacturers and recyclers are required if the government is determined to tackle waste management challenges, resulting from its increasing quantity, and to promote a green economy paradigm through the waste sector (Ngoc and Schnitzer, 2009).

For most cities in Indonesia, waste management is undertaken as a public service with high expenses that includes capital costs of infrastructure, equipment and labor. Therefore, many cities in developing world could not afford to collect and dispose of MSW properly. In Jakarta, over 35% of the government budget is allocated for MSWM, among which almost 90% is used to cover waste collection, while the rest expenditure is for transportation and waste disposal (Kardono, 2007). However, there is still 40% of the waste uncollected and only 50% of the urban population is served by the collection service (Yulinawati, 2005). As a result, the rest is recovered and recycled by scavengers. While low budget allocations, limited public participation, and poor waste management from collection to final disposal are the main reasons for local government to resort to open dumping method (Elizabeth, 1992), the lack of coordination among responsible institutions/agencies, insufficient regulatory capacity, and flexible law enforcement represent structural deficiencies in the country's waste management

system (Kurniawan et al., 2013). Therefore, reformation of waste management policies in Indonesia is necessary due to the continuous increase of waste generation.

The successful implementation of market instruments in the BW state has stood for a good target-of-learning for Indonesia. However, market instruments are difficult to apply towards some waste streams like the waste generated at public venues, which could not be charged accordingly. In Indonesia, MSW still does not carry a price tag, corresponding to the marginal social costs of waste collection and disposal for different generators. Consequently, the cost of waste disposal is low and reflects an under-pricing of its capacity service to the environment (Levine and Sandra, 1994). Bohm (1981) suggests the need for economic instruments such as unit-pricing schemes to address the problem. If applied properly, these instruments would increase the prices for environmentally-damaging goods and enhance their returns, thus changing their consumption-oriented life styles (Miranda, 1993).

A pragmatic approach is to charge a fee according to the quantity of the total waste individual households generate (Miranda et al., 1994). Considering that the costs of waste management are usually accompanied by economic benefits either savings through waste minimization or resources recovery through recycling, the unit pricing approach represents an ideal option to charge waste generators for collection and disposal services based on volume. Through two-tier pricing (Tietenberg, 1994), two types of fees could be charged to households. The flat fee covers a minimum degree of services such as the disposal of one bag per week, while the unit-based price varies depending on the number of additional bags collected weekly from households. While setting a threshold limit below which charging households for the disposal of domestic waste could be waived, the fees on a volume-based system should be set at an affordable level.

Unlike the flat fee, the unit pricing provides households with direct incentives to minimize waste generation and to encourage waste-reduction behaviors such as purchasing style toward products with less packaging or with recyclable packaging on one hand. On the other hand, companies in the production sectors will consider redesigning their product's packaging if there is good return for their efforts. For example, a product based on eco-design perspective can be commercially sold at a higher rate in the market. Principally a unit-pricing system will increase the marginal cost for waste generators, which reflects the real cost of waste management services such as processing, storing, and setting out waste for collection

(Stavins, 2000). The authors argue that charging households a full fee, which reflects the costs of collection and disposal, would reduce the quantity of MSW generated at its source.

In this regard, unit-pricing programs are likely to be successful if implemented in Jakarta. In the capital, residential MSW is regularly picked up curbside. As households commonly dwell in multi-family buildings, the normal practice is to share the total waste disposal costs among them equally. This program would facilitate changes in their behaviors towards waste reduction. To a certain extent, Miranda (1993) argued that this weight-based waste disposal fee generates economic incentives among the households and contributes to economic development by supplying waste services. Therefore, efficient, reliable and low-cost MSW service is essential to the development of an urban economy not only for creating job and generating incomes in the waste industry, but also for providing public with better environmental services (Stavins, 2000).

To attract the involvement of households in waste reduction, it is suggested that unit pricing could be integrated with recycling program. This would not entail charging a fee for the collection of recyclable materials if the households separate useful materials from the other streams. In recycling, potential trade-offs need to be considered when trying to encourage source reduction and materials diversion. Unlike recycling, unit pricing facilitates source reduction and waste diversion. The higher the unit price is, the stronger people's participation in source reduction and recycling will be. If the unit price is set too high, waste generators may respond to it by disposing of their waste illegally. Miranda (1993) argued that charging for waste generation by means of unit-pricing would improve people's awareness of the economic costs of the waste they generate. To what extent waste generators may respond to a higher unit pricing with source reduction depends on the degree of substitutability between high-garbage- and low-garbage-generating products. Without considering its substitutability, Miranda (1993) argued that source reduction still occurs due to the monetary implications of accruing a higher charge on waste services. Hence, consumers require goods that generate the same level of consumption utility, but produce less garbage.

Another option is to charge a tax or levy on certain products, which represent major problems in a waste stream, during its sale through special arrangements. If the price for waste disposal is zero, a deposit-refund per tonne of MSW required to meet a certain target of reduction would be the marginal cost of waste reduction (Miranda et al., 1994). As the fee represents a charge on waste that is disposed of, waste generators need to adjust their behavior to enable

the charge to equal the marginal cost of waste disposal reduction. Compared to unit pricing, the deposit-refund system (DRS), which can generate funds for reuse and recycling purposes, is relatively less costly to facilitate source reduction (Bohm, 1981).

The DRS also involves market mechanisms. The market-generated system could not work efficiently if the refund level was higher than its net reuse value for certain goods. This indicates that the German successful experiments with market instruments provide valuable lessons on the need for monitoring and enforcement through a command and control approach. The market instruments, whether price- or quantity-based, would not eliminate waste generation activities, but might change people's behavior with respect to waste.

There are pro and cons to promoting market instruments for MSWM in Indonesia. Poerbo (1991) argued that a disposal fee, collected from waste generators, can be invested to improve the current system, thus sending the government's pressure on capital shortage concerning MSWM. As waste disposal fees contribute to government revenues, the implementation of market instruments can improve the economic and environmental situation in Indonesia in the long-term. They would help decrease waste disposal in local landfills because households would put efforts into minimizing MSW and maximizing materials diversion through recycling and recovery. Through materials and energy recovery from the unused MSW, an integrated solid waste management at household level can reduce GHG emissions significantly from landfills.

In spite of its promising potentials, the introduction of waste disposal fee to waste generators may not automatically give the expected outcomes. According to Miranda (1993), this could be due to the inability to monetize a suitable price tag for the total costs attributed to environmental damage. In addition, it is difficult to charge households the waste disposal fee efficiently and effectively. Unlike other goods, environmental damage does not have a fixed price tag. There is no single calculation that could determine the entire cost of environmental damage caused by waste disposal. If the fee for waste disposal is low, households do not have proper incentives to alter their behavior; in contrast, a higher fee could lead to illegal waste disposal elsewhere. Therefore, market mechanisms would be involved to facilitate the recycling program and to address environmental externalities.

In addition to the positive aspects, there is criticism towards introducing market instruments for MSW collection services. As an opponent of market instruments, Stavin (2000) argued that

this instrument could encourage negative waste disposal through illegal dumping. Since unit-pricing encourages households to reduce the burden of waste disposal through recycling, the balance between monetary and household time costs should be taken into account. Other difficulties in applying this unit-pricing option include the absence of any complete analyses of its effects on the environment, costs, and revenues, which can be unpredictable, since they depend on the response level by individual households to waste disposal charges. In spite of those drawbacks, ideally market instruments have to remain a fundamental part in reforming waste management approaches in Indonesia.

3.3 Policy Implications of Introducing Market Instruments in Indonesia

If Indonesia were to adopt the green economy approach with respect to MSWM practices, there would be a number of policy implications that the country would need to address and consider. Presently, the lack of environmental policies and regulations presents an obstacle to undertaking best practices of MSWM through recycling. The authors suggest that the central government needs to issue environmental laws and strictly enforce a recycling program. In Germany, recycling is undertaken by both private and public systems. Over 300 local municipalities in Germany participated in waste separation at its source. Since Germany has Laws in place on market instruments such as DRS, it can arrange a waste disposal fee and determine the potential quantity of waste that will be generated after manufacturing. It is important that manufacturers and consumers should be responsible for treatment and disposal costs of unrecyclable or non-environmentally friendly products. In this regard, manufactures need to apply a life-cycle approach from product design to production, packaging, use, and re-entry into the waste hierarchy after end of life. Every part of the life-cycle of a product offers opportunity for intervention to generate less waste.

In addition, the Indonesian government needs to involve stakeholders such as waste generators at household level through recycling program. The authors argue that the effectiveness of the recycling program depends on public participation. Since households are the main waste generators in Indonesia (Hoornweg and Tata, 2012), waste sorting and separation should start at home to minimize time and collection costs. Whether the incentive to generate less MSW is created depends on the waste disposal charge. If the charge is set

based on an average of the waste generated per household unit, there is no real incentive for waste minimization (Levine and Sandra, 1994).

As evidenced by German experiences, the Green-Bin program is a very powerful tool in promoting the separation of waste and retrieval of useful materials. So far, over 22 millions households have been involved in the program (Zhang et al., 2010). Needless to say, effective waste separation at its source requires active participation and cooperation from governmental, public and private sectors. By implementing a "zero-waste" policy, where close-to-zero waste generation is enforced through waste minimization, Germany ensured the environmentally compatible disposal of waste and attained a recycling based-economy that conserves resources and reduces adverse impacts on the environment (Miranda et al., 1994). Indonesia could directly emulate the German successful experiences by optimizing an efficient use of raw materials, maximizing recovery and removing the residual waste with no economic value.

3.4 Applying Co-Benefits to Waste Sector in Indonesia to Move Towards a Green Economy

According to the 3rd Assessment Report on Mitigation of the Intergovernmental Panel on Climate Change (IPCC), the co-benefits approach represents an integrated effort to address climate change concerns, caused by an over-generation of solid waste, while simultaneously promoting local development needs (Oliveira and Kurniawan, 2013). This holistic approach aims at addressing local environmental problems from waste and energy sectors in the framework of a green economy. The phrase itself refers to 'an economy which recognizes the value of resources that is traditionally undervalued or not valuable at all and optimizes resource use' (UNEP, 2004).

Since huge differences of social and economic development are observed between Jakarta in Indonesia and BW in Germany, a number of improvements of MSWM with market instruments in the BW state have been carried out to adapt to unique circumstances in Indonesia using a variety of co-benefit initiatives. Since 2007, co-benefits approach has been one of the basic principles for national actions in maintaining friendly urban development by integrating low-pollution and low carbon measures into the waste sector (Meidiana and Gamze, 2011). The co-benefits approach has been implemented by promoting a triple track

strategy – pro-poor, pro-job, and pro-growth – with a pro-environment principle. In this regard, the community-based solid waste management (CBSWM) scheme represents one of the co-benefit approaches used to reduce the amount of waste and to improve resource circulation by specifying the obligations of relevant local stakeholders (government and waste producers) to the life-cycle of a product (Santosa, 2000). In the long-term, the CBSWM scheme could reduce the impacts of urban waste on climate change, especially when urban dwellers still treat their trash in unsustainable ways.

To implement the CBSWM scheme, local municipality played key roles in formulating and implementing appropriate environmental policies and regulations to support CBSWM at local level. Since 2003 Sukunan, a village in the suburban area of Yogyakarta, was selected to undertake waste management based on co-benefits principles by adopting ISWM and resource recovery approaches. The ISWM principle was implemented by local community in several ways, starting at source by separating refuse and composting organic waste at household level. Subsequent steps involved the organized collection and processing of recyclable waste, which was made into handicraft articles or sold as scrap to trash collectors, who could deliver it to recycling centers. This approach would divert valuable materials for re-use and recycling and minimize the amounts of waste disposed of in local landfills. So far, the ISWM has worked effectively in a co-benefits sense, as the environmental health, livelihood, and sense of ownership of the people within the community have been improved.

Stimulated by economic benefits, small and local entrepreneurs, named the scavengers, are involved in the collection of valuable inorganic waste and are the key actors in this business. Households earn money from the sale of inorganic waste, while scavengers purchase the valuable waste. In addition, each household makes compost that could be commercialized in the market. As a result, more people have become interested in joining the waste industry in recent years.

After nine years of practice (2003-2011), the number of CBSWM units in various regions in the Yogjakarta province had increased substantially (Figure 3) to address MSW generation problem. This indicates that the CBSWM scheme has remarkably reduced the final waste output of the local community compared to the common practice of bulk collection and mass disposal. In the Sukunan village, the implementation of the CBSWM scheme has achieved 90% reduction of MSW that must be deposited in landfill once (Figure 4).

After applying 3R to local MSW, approximately 0.2 Mt of CO2 emissions could be reduced annually. Consequently, about 19,000 t of CO2 emitted from local landfills were avoided according to the mathematical life-cycle analysis (LCA) framework reported earlier by Menikpura et al. (2013) in the same journal:

GHG Avoidance/savings = (1)

where PA represents potential avoidance of ith GHG via materials/energy recovery or avoided landfilling, while EFi is the equivalency factor of ith GHG.

This promising result is in agreement with another waste treatment technique undertaken in Muangklang, one of the municipalities in Thailand, which attained GHG savings of 385.58 kg CO2-eq/t of collected MSW from a local ISWM system (Menikpura et al., 2013). In terms of environmental benefits, this net CO2 saving represents a significant achievement of the CBSWM practices in GHG emission reduction (Gentil et al., 2009), since most of the GHG emitted from landfills might be diverted or be collected through composting activities (IGES, 2009). If the Sukunan community could continuously improve 3R implementation by sorting recyclable materials and utilizing their organic waste through composting, the village could attain “net zero GHG emissions” in the long-term (Kurniawan et al., 2012). By increasing the composting rate of organic waste, the village could reduce GHG emission at local level via energy and material recovery.

In addition to environmental benefits, over US$ 0.2 million of expenditure was saved in the provincial budget for waste management. This was attributed to waste avoidance and the creation of added value from the recycled waste through co-benefit initiatives. In addition, the CBSWM program has improved the living conditions of neighboring communities and created job opportunities such as waste composting, which generates additional income for local community. They may commercially sell their compost at US$ 0.07 per kg (Akenji, 2011).

Waste composting could recover valuable resources and collect CO2. This activity also has minimum impacts on the environment and does not compromise local public health (Dijkman, 2000). In fact, the use of locally available micro-organism for fermentation purposes inside the Takakura bins significantly shortens the time required for waste decomposition from three months to three days only (Kurniawan et al., 2013). In tropical countries like Indonesia, the composting process rapidly takes place. In the Sukunan village, this low-cost compost method

will help local farmers supply nutrients for agricultural farming and facilitate a higher production yield.

Due to extensive public participation (Tahir et al., 2011) (Table 5), the Sukunan village has become a role model for waste management nationwide and promoting CBSWM activities. In the same village, public participation reduces waste at source through a variety of co-benefits initiatives and helps local government to cope with the lack of public budget for waste management.

Just recently the village has become an Eco-Tourism Village in Indonesia. Inspired by the promising results, local people continue to develop their village in order to conserve a significant amount of valuable materials and energy as well as to improve their livelihoods and to promote environmental protection. Sukunan's achievement in controlling MSW generation has proven the effectiveness of co-benefits approaches in GHG emission reduction, thus encouraging other cities in Indonesia to embark on ISWM for a greener neighborhood. As the replication of CBSWM nationwide would facilitate co-benefit effects in local urban areas, it is important to develop environmental policy in a way that takes into account regional needs and its capacities when promoting practical solutions for local MSW problems.

4. Concluding Remarks

This case-study has demonstrated that the Sukunan village in Yogjakarta (Indonesia) has successfully carried out climate-friendly waste management in recent years after having applied important lessons from the German best practice of MSWM in the context of co-benefit approaches. Consequently, this experience at community level could also be directly transferable and applicable to China, India, and the other Asian emerging market countries. In policy spheres, the countries need to integrate MSW management policy approaches that incorporate market instruments and co-benefit initiatives as key-drivers both for controlling waste generation and for mitigating GHG emissions. In tandem with ISWM approaches in their implementation, environmental benefits in terms of substantial CO2 reductions, economic gains and social benefits have proven to be accessible by a demonstration village.

Before accomplishing this purpose, pilot projects are necessary to assess the reaction of local households toward the implementation of market instruments like waste disposal fees and to

determine the amount of money charged to waste generators as a fee. It is important to strike the right balance between the levy and the associated administration cost in collecting the levy, as the waste disposal fee charged to MSW in Indonesia could be an additional burden to a family unit, who is often heavily populated (over 5 persons per family unit). The associated levy could be used to subsidize other programs on waste reduction, resource conservation, or environmental education. Imposing a direct tax on manufacturers and/or importers is effective in addressing waste generation. The tax collected could be used to develop recycling industries, integrated waste management facilities and educational resources in Indonesia. By integrating market instruments into its MSWM practices, Indonesia could make positive changes in its environmental policy and regulation on MSW, while ensuring the economic sustainability of waste management activities nationwide.

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