

Municipal Solid Waste Management in Developing Countries: Future Challenges and Possible Opportunities

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1. Introduction

Most developing and least developed countries are currently facing serious development challenges that may be enhanced if some old traditional development plans are still in persistence. In the wake of the recently emerged global economic crises development challenges are expected to be increasing as a result of the adverse impact on the capabilities of developed countries to offer needed assistance to developing countries. Since the 1992 Rio Earth Summit and later the adoption of the Rio Declaration and Agenda 21 and following the declaration and adoption of the millennium development goals (MDG) in 2000 things on the ground have not significantly improved. The United Nations' recently released a report that shows that most developing and least developed countries are far from reaching the MDG targets set for the year 2015 (UN, 2010). The impacts are expected to exceed the continuous widening of the gap between the developed and developing countries to the extent that might badly affect sustainable development. After more than two decades from the adoption of the notion "sustainable development", it could be claimed the notion was portrayed in different ways when comparing developed to developing countries. Developed countries treat Sustainable development as an environmental concept placing the emphasis on inter-generational equity focusing on future needs (Carter, 2001), while most developing countries are placing emphasis on intra-generational equity focusing at present needs which are often social and economic ones. Such different portrayals played significant role in shaping the capabilities of developing countries to meet the sustainable development challenges they are facing and consequently in widening the gap between developing and developed nations.

In this context it is important to shed light on major challenges facing sustainable development in several developing countries. These could be summarized as follows:

- **Population growth:** the Population Reference Bureau (PRB) projected the 2050 world population to a range from 9.15 – 9.51 billion with different decrease in fertility rates in many developing and least developed countries (Bremner et al, 2010). The largest percentage increase by 2050 will be in Africa where population is expected to jump to more than 2 billion. Asia with 4.2 billion will likely experience smaller proportional increase than Africa, however this depends on China and India, where both populations account for about 60% of total Asia's population. Latin America and the Caribbean are expected to experience the smallest proportional growth due to fertility

declines in several of its largest countries, such as Brazil and Mexico. The age structure of most countries in Africa, Asia, and Latin America favors young population at working age that, if well managed, could be the driving force behind economic growth prosperity or, if improperly managed, could adversely impact socio-economic growth. The expected decrease in fertility and increase in youth will lead to the “demographic dividend” where youth populations become older and have fewer children of that previous generations leading to a bulge in the working age population. This represent a window of opportunity for developing countries to save money on healthcare and social services and to invest more on technology and capacity buildings to strengthen economy and to cope with future aging of the population.

- **Public health:** The World Health Organization report on World Health and MDG (WHO, 2010) showed that over the last decades average annual mortality rate in children under 5 years old in most developing countries has fallen by a range of percentages from 1.7% (in Eastern Mediterranean Region), 1.8% (in Africa) to 3.8% in south and east Asia region. Despite these encouraging trends, the report indicated several health problems that still in persistence such as maternal mortality and HIV/AIDS. The estimated number of death caused by malaria in 2008 is 863000 with 243 million estimated cases. Health implications due to poor sanitation facilities are considered very serious. The same report estimated that in 2008 over 2.5 billion people were not using proper sanitation facilities resulting in high level of environmental contamination and exposure to risks of microbial infections. Death caused by non-communicable diseases or injuries in developing countries totaled in 2004 to 33 million. The absence of adequate healthcare systems will still adversely affect the public health conditions. Health problems caused by poor hygienic and sanitation conditions require improving and upgrading infrastructure for waste management and introducing the integrated management approaches.
- **Vulnerability to climate change:** the Intergovernmental Panel on Climate Change (IPCC, 2007) defined vulnerability of people as their propensity to be harmed due to their exposure to stresses including climate stress. It is believed that the continuous increase emissions of greenhouse gases (GHG) several decades ago due to human anthropogenic activities resulted in the global climate change, which turned to be the most serious challenge facing development in the 21st century. The accumulation of GHG emissions in the atmosphere, in particular carbon dioxide (CO₂) and Methane (CH₄) is believed to be responsible for the global warming and the associate frequent occurrence of extreme climate events. CO₂ concentration in the atmosphere has risen to 391 ppm by end 2010¹; an increase of about 6% compared to records of 2000. The 2010 world energy statistics (BP, 2010) show that 44% of total CO₂ emission comes from 17% of the world total population (developed nations) while the rest 83% of the world population (developing and least developed) contributes to the rest half of the total emissions (figure 1). climate events such as floods, storms, droughts, hurricanes, etc., and the rise of sea level resulted from melting of the glacier covers are also observed (IPCC, 2007). As vulnerability to climate change is shaped by factors such as the population dynamics and economic status as well as adaptation measures such as appropriate norms and codes, it is likely that people in developing and least developed countries will be more vulnerable compared to those in developed countries. Adverse

¹ In <http://co2now.org>

direct impacts on health, land-use, agricultural productivity, water resources availability, etc. may further heightened and indirectly impact population, economy, and social-economic growths butting extra burdens of development processes on developing countries.

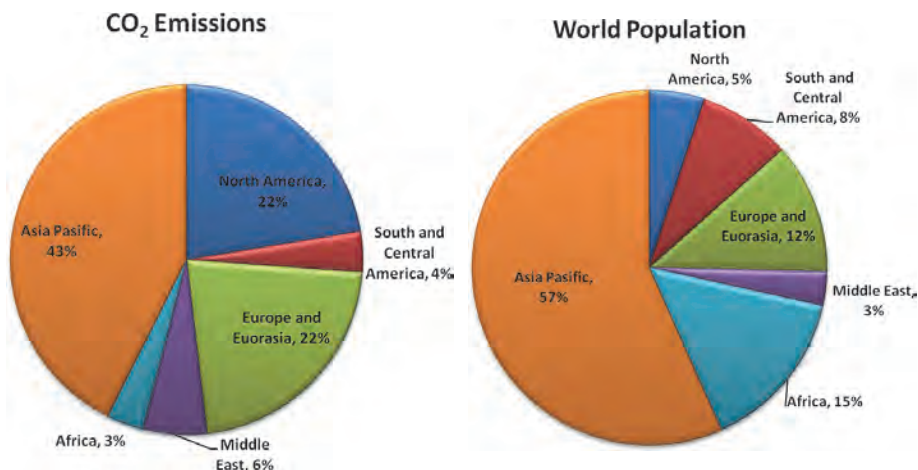


Fig. 1. Comparison of World Population and CO₂ emission

- Human development and the economical growth:** the 1990 Human Development Report states that “People are the real wealth of the nation.” (UNDP, 1990) putting people at the center of the development process, which objective is to create an enabling environment for people to enjoy long, healthy and creative lives. The UNDP recently released the 2010 human development report (UNDP, 2010) which indicated that developed countries have recorded considerable economical growth in the last four decades compared to developing countries. The un-attainable convergence in income between the developed and developing nations resulted in setbacks, particularly in service such as health and education and consequently on human development and on the sustainable development process as a whole.

2. Solid waste in developed and least developed countries in the context of development

The last three decades witnessed the development in urban areas over rural ones in a process called urbanization. Growth of urbanization is much more in developing countries than the developed countries (figure 2) to the extent that it became a trend characterizing several developed and even least developed countries. Growth in urbanization is coupled with the growth of population living in urban areas. In e.g. China, urbanization led to increase in urban population to about 35% percent of its total population with annual growth in urban population of about 4%. Similarly, it is anticipated that by 2025 Asian urban population will reach 50% of the total population; and probably more. This expected increase will cause major shift in the distribution of the countries’ populations and will lead to the expansion of urban boundaries (World Bank, 2003).

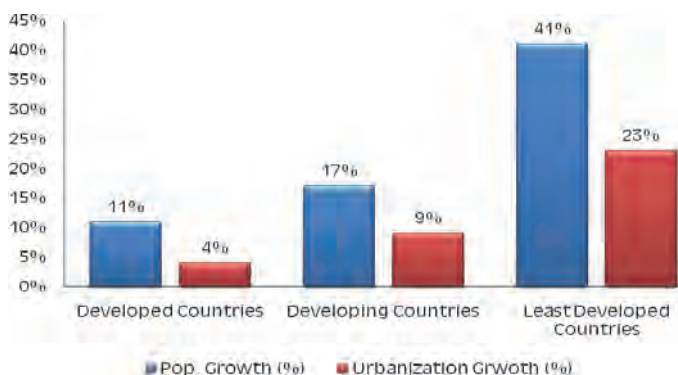


Fig. 2. Population and urbanization growth (1990-2010)

The reality is that the growth in urbanization does not always mean improving situations, including sectors developments. In the recently published 2010 human development report (UNDP, 2010), indicators that describe the accessibility to water and sanitation in developing and least developed countries are not encouraging at all. It is found that an average of about 45% of countries' populations are lacking proper sanitation infrastructures, and an average of 20% are lacking proper accessibility to water. In addition, the report showed that the percentage of populations living on degraded land is increasing to an average that exceeds 15%. Hence, the consequence of the unplanned urbanization growth will definitely lead to huge problems on governments especially for meeting the increasing demand for proper and healthy municipal services. The growth will result in increase in the quantity and complexity of the generated wastes and overburdens, including solid wastes, and in particular municipal solid waste (MSW). MSW includes materials discarded for disposal by households, including single and multifamily residences, and industrial waste from canteens/restaurants and hotels and motels and from commercial and industrial entities essentially the same as waste normally generated by households and collected and disposed by normal municipal solid waste collection services. Such MSW is considered a problem that having impacts on the environment and the public health if not properly managed. Comparing conditions related to MSW management in developed and developing countries brings indicators that quantify the problem. Considering the MSW generated in general, its main constituents are to some extent similar throughout the world, but the quantity generated, the density and the proportion of streams vary widely from country to country depending mainly on the level of income and lifestyle, culture and tradition, geographic location and dominant weather conditions. Low income countries with yearly per capita GDP that does not exceed US\$ 5000 have the lowest MSW generation rates, which are in the range 0.3 – 0.9 kg/capita/day. The increase in per capita daily generated waste is found linearly proportion to the per capita GDP. In high income countries it reaches a range of 1.4 – 2.0 kg/capita/day. Figure 3 shows the linearly coupled GDP to Waste generation rate diagram with examples from countries of low, medium, and high incomes. Another element that characterizes differences between the generated MSW in low and high income countries (developed and most developing countries) is the percentage composition of MSW constituents. There, the lifestyle of peoples decisively characterizes the percentage composition where organic waste stream and overburden form more than 50% of the total

generated MSW. This is the opposite in high income countries, where lifestyle favors fewer homes cooking, relying mainly on the readymade backed food. This is reflected in the figures that represent the percentage of organic waste stream which does not exceed an average of 30% of the total generated waste and that more packing material characterizes the MSW. Figure 4 shows the differences in parentage compositions of MSW between high income countries (developed and some developing), medium income countries (most developing) and low incomes countries (some developing and least developed countries).

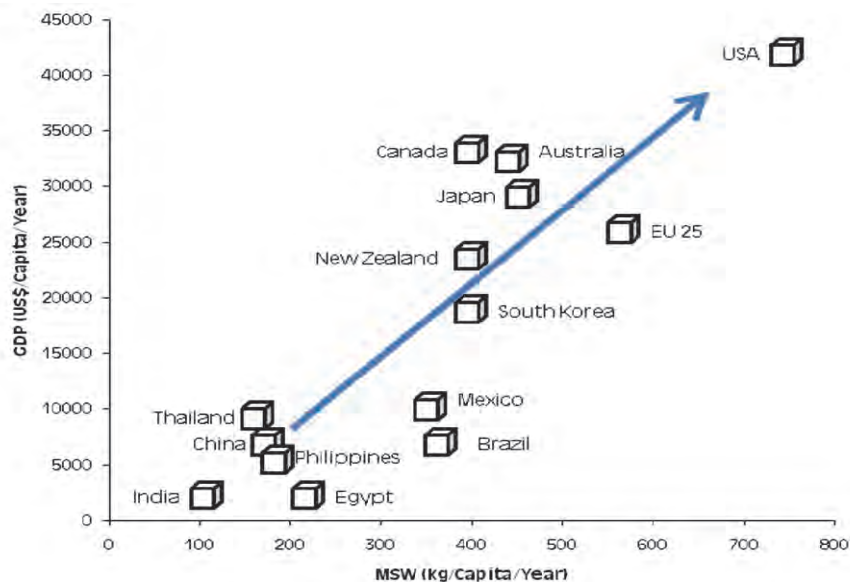


Fig. 3. Countries income and the rate of generated MSW (UNDESA, 2010)

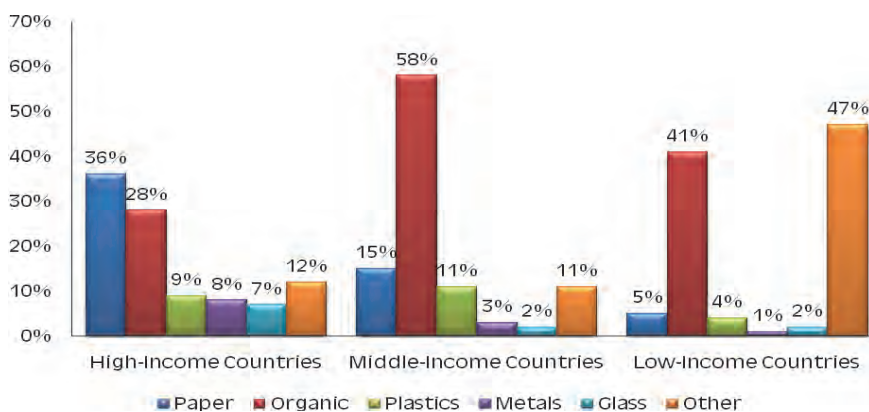


Fig. 4. Characteristics of MSW streams depending on income (UNDESA, 2010)

In urban areas of most developing and least developed countries generated MSW is at best collected and dumped in arbitrary dump sites that mostly lack the appropriate norms. Such disposal requires collecting, transport and dumping into the nearest open space area. In other countries MSW is dumped into water bodies and wetland and part of the waste is burned to reduce its volume. Such practices have their adverse environmental impacts ranging from polluting the natural resources and the ecology to the creation of health problems which might turn into long-term public health problems. Studies conducted in the last decade in several developing countries showed that same old non-environmental sound practise are still used. Although lots of significant efforts have been done in the last few decades in many developing countries supported technically and financially by developed countries and international organizations, substantial reforms in the management of MSW are still not attained. This is due to the fact that frameworks recommended where mostly similar to that adopted in developed countries but without seriously addressing the socio-economic differences between the developed and developing countries.

In the Middle East there are countries of high income (e.g. Saudi Arabia, UAE, Kuwait, Qatar, and Israel) and other of middle and low income countries. The per capita rate of generated MSW shown in figure 5 (Kanbour, 1997, Mashaa'n et al, 1997, Al-Yousfi, 2002, METAP, 2004, Israel MEP, 2010) is rather diverse but reflects the country's income level. However, when looking at the percentage composition of MSW constituencies shown in figure 6 (WH, 1995, Al-Yousfi, 2003, METAP, 2004, Israel MEP, 2010), it could be realized that the major MSW stream in Arab countries of the Middle East is organic. This is primarily due to the fact that these countries share a common lifestyle and eating habits.

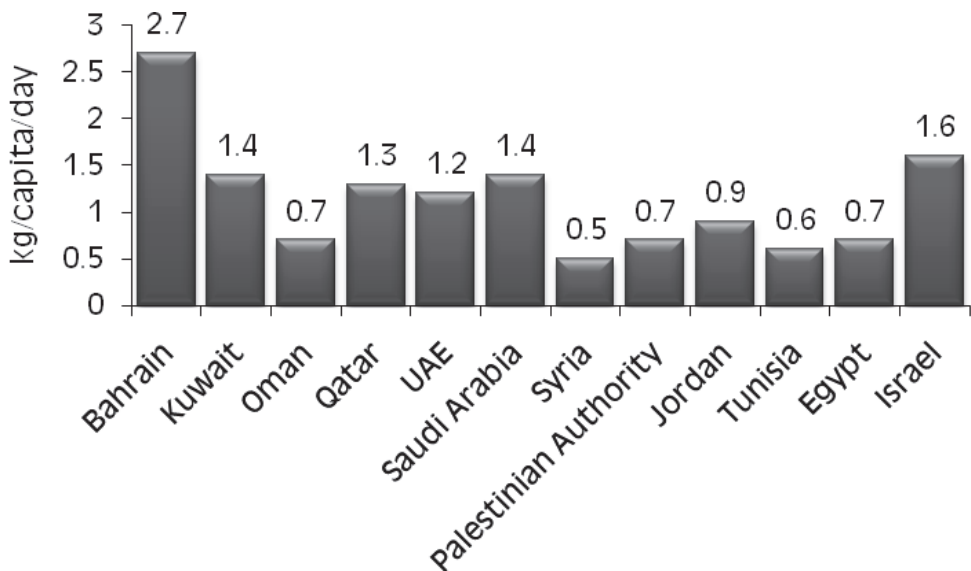


Fig. 5. MSW generation rates in countries in the Middle East

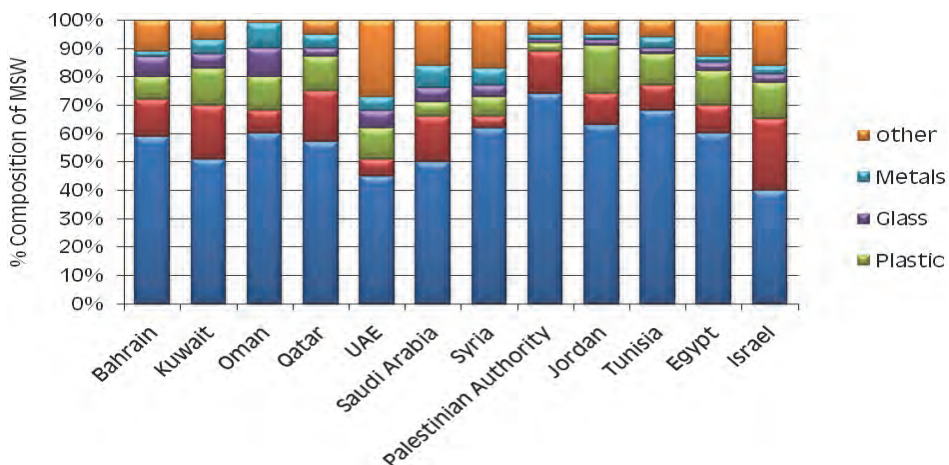


Fig. 6. Percentage composition of MSW in some Middle East countries

Countries of medium and low income in southeast Asia have similar per capita rate of generation of MSW but they have different percentage composition of generated MSW streams. Figure 7 (Glawe, et al, 2005) shows the diversity composition of MSW where organic overburden dominates in most countries.

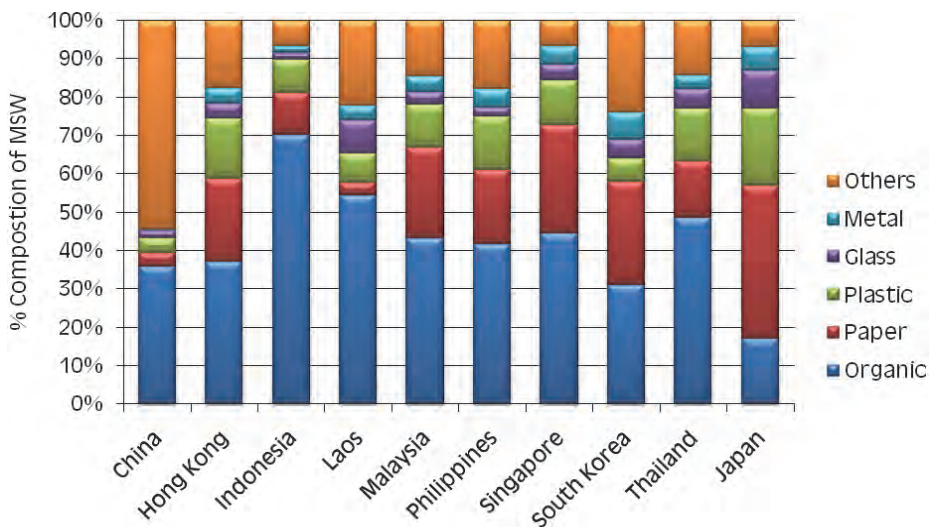


Fig. 7. Percentage composition of MSW in some Asian countries

It is clear that most of the generated MSW constituencies in most developing countries are decomposable and recyclable. If properly managed, such MSW would provide high opportunities for the development of the socio-economy of the countries. However, the fact

is unfortunately the opposite as the MSW remains a socio-economic that faces many problems.

There are diversities of management options of MSW in the different developing countries. In Egypt, which is an African Middle East Arab country 75% of the MSW is generated in urban areas. Total estimated MSW for 2025 is expected to reach 33 million tons for a growth rate of 3.2% based on 2001 records. Collection services cover less than 30% of urban and rural areas and the rest are disadvantaged. A portion of 8% of the total collected MSW is sent to compost plant but the rest is sent to dump sites scattered in the country open spaces posing high risk to public health and the environment (METAP, 2004). This is very similar to the situation in many developing and least developed countries of the region such as Syria, Jordan, and the Palestinian Authority as well as countries in Southeast Asia, Africa, and Latin America. Israel on the other side has generated in 2006 around 6 million tons of MSW and Industrial waste from urban and rural areas. The solid waste services cover almost all regions in the country. There are more than 15 state of the art landfills located in different regions in addition to recycling plant where 23% of the total generated waste (i.e. 1.4 million tons) are recycled (Israel MEP, 2010). In the Gulf Arab countries and specifically in the UAE some 25% of the generated MSW in Dubai, Abu Dhabi, and Sharjah is diverted to compost plants. MSW in other emirates of the UAE is collected and sent to landfills (UAE-ME, 2006). Particularly in Dubai more than 60% of the emitted methane is recovered.

It is clear that the main problem facing the proper management of MSW in many developing countries are the lack of adequate administrative and financial resources. There is no clear reliable framework by which the solid waste sector is administered from the collection, transformation to disposing or treatment phases. This situation is usually coupled with limited investment allocated for the MSW sector with complications of collecting or raising proper service fees. The management activities of MSW are considered public services which are directly controlled by governmental institutions. Such management arrangement is considered weak as it lacks the market mechanisms, and in this case economical incentives cannot be used to improve and develop the MSW management services.

Another related common problem is the absent of effective and comprehensive legislative frameworks governing the solid waste sector and the inadequate enforcement mechanisms, which are no less important than the legislations themselves. Such shortcomings in the management of MSW create gaps and intensify the problems. Standards and norms are also critical for the implementation of the legislative frameworks especially that concern the setting, design, and operation of the landfills and the dealing with possible hazardous and healthcare wastes. In many developing countries where financial resources exist, shortcomings are found in both the human and organizational capacities. In Palestinian Authority donors have spent considerable amount of funds for rehabilitating devastated infrastructure and for providing facilities for the collection, transportation, and disposal of solid waste but they have compromised building the needed institutional and human capacities and raising the public awareness (Khatib and Al-Khateeb, 2009). This created a problem that was only recently rectified as will be elaborated in the successive sections.

The last significant problem related to management of MSW is the availability of the significant amount of accurate background data and information on the status of solid waste, including MSW, such as rate of generation of different solid waste constituencies, assessment of natural resources and land-use, collection and transportation needs, scenarios of treatment, growth scenarios of solid waste which is linked to several driving forces. Data and information are the crucial elements for developing MSW management system including the adequate monitoring of the sector.

To overcome the a.m. main problems, the following prerequisites should be addressed and dealt with:

- Institutional set up,
- Human awareness and capacities,
- Proper standards, laws, guidelines and norms,
- Proper infrastructures,

Enabling management of the generated solid waste in an adequate approach will mitigate any adverse impacts to the environment, natural resources, and the public health, which are obviously the main aims of MSW management. In developed countries integral management of MSW has reached an advanced stage where MSW are reduced in amount at sources, i.e. before collection. This has been achieved with both, the intervention of the available technology and the public awareness. Technology has provided better design for the consumable products with less material in size, weight, and packaging. In addition same technology offered the possibility of at source re-using products' packaging. The benefits of this integrated management approach are many, including:

- Conservation of natural resources,
- Reduced amount of waste to be recycled or transported to landfills or waste recycling facilities. ,
- Decreased air pollution and the production of greenhouse gases,
- Reduced toxicity of waste, and
- Reduced costs of waste collection and disposal.

Developed countries have also succeeded in applying different treatment and re-use methods for the generated MSW, including; recycling, composting, and energy recovery, in addition to the disposing of the waste in proper landfills.

It should be emphasized however, that as long as impacts of MSW are properly mitigated, there are no overall 'best' or 'worst' approach and that the conditions in persistence and the identified driving forces for any country; whether developed, developing or least developed, should provide baselines for the best integrated feasible approach.

3. The integrated sustainable solid waste management approach

The integrated sustainable solid waste management (ISSWM) was first developed in mid 1980s by a Dutch NGO called WASTE² and further developed in 1990s by the Collaborative Working Group on Solid Waste Management in Low- and Middle-Income Countries³ (CWG), then it became as a norm. The ISSWM is a system approach that recognizes three main dimensions including stakeholders, elements, and aspects. These dimensions are shown in figure 8.

The stakeholders are the people or organizations participating in solid waste management. This includes the waste generators who use the services, the service providers, the formal and informal private sector dealing with solid waste management, and other local or international institutions. Elements comprises the technical components of the waste management system starting from the generation of solid waste then the collection, transfer and transportation of waste to dumpsites or to treatment plant. Treatment ranges from

² <http://www.ecosan.nl>

³ <http://www.cwgnet.net>

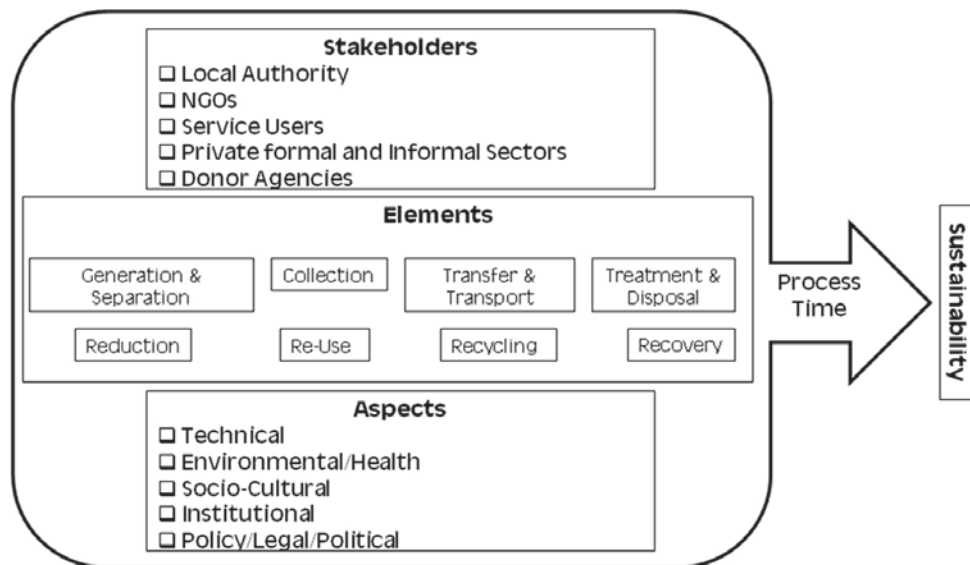


Fig. 8. Integrated Solid Waste Management (Source: <http://www.ecosan.nl>)

reducing the size of the generated waste to recovery of the waste, in particular the biodegradable component that comprises more than 60% of the total municipal solid waste generated in urban areas of the developing countries. In order that the integrated waste management be sustainable, all required aspects, such as financial, social, institutional, political, legal, and environmental that assesses the feasibility of the management should be addressed in a sustainable way. The different dimensions are interrelated and their linkages institutionally, legally, and economically enable the overall function of the system. It could therefore, be indicated that ISSWM considers MSW management not just a technological system with infrastructure and facilities that facilitate handling and disposal of MSW, but it is a management system that consider and deals with many other elements including the socio-economic settings, the physical environment and growth in public demands and management scenarios.

Several principles of ISSWM were extensively based on contributions of many authors (i.e. Moreno et al., 1999, Coffey, 1996, Schuebeler et al., 1996, van Beukering et al., 1999). These could be summarized based on figure 8 as follows:

- Technological and operational principals should be adapted to the physical setting, local environment, and land use, of the region. Efficient technology should be preferably a local efficient technology that reliably provide spare parts and efficient O&M,
- Environmental and health principles that ensure that any technical setting is clean with the minimal impact on the environment and its elements. This is attained by following the waste management hierarchy preferring options that promote waste reduction and separation at sources,
- Financial principles should ensure “all beneficiaries contribute principle” in which fees are collected for the services and in return relevant government institution contributes

by allocating revenues to MSW. Financial principles should ensure highest productivity of labor relying of capital intensive system and not on labor intensive. Full cost recovery should also be considered,

- Socio-economic principles that permit public in all regions to receive adequate and affordable management system without any adverse health impacts while acknowledging the different economical incomes of beneficiaries,
- Administrative principles necessitate building the capacities of the personal involved in the management of MSW, in addition to encouraging the involvement stakeholders in the planning and implementation of the management activities,
- Policy and legal framework principles, that while support decentralizing of relevant authorities and finance they, at the same time, encourage the involvement of stakeholders including non-governmental organizations and the private sector.

4. Palestinian authority and the newly adopted ISSWM

Palestinian Authority (PA) is considered as a developing entity having many in commons with other developing countries. It is only after the emerging of the PA that development in the Palestinian territories started taking place although it has been heavily retarded after the Israeli re-occupation of the Palestinian areas in 2002 in response to Palestinian second Intifada (Uprising). The solid waste sector is managed by different institutions. In towns and villages, municipalities and village councils are providing the services whereas in refugee camps the United Nations Relief and Works Agency (UNRWA) is taking care of the services. The long-term occupation with its daily harsh measures against Palestinians and their infrastructure have exerted heavy burden on the PA and other responsible institutions for launching a complete development process. In 2009 and with the help of donor countries and institutions, the PA has started preparing its first strategy for integrated solid waste management while facing huge challenges similar to those facing other developing countries and mentioned previously in the chapter. Although the Europeans and World Banks have both supported the sector over the period 1994 until 2010 with a total of US\$ 72.274 million (Palestinian Authority, 2010) very little progress has been witnessed. This is due to the fact that the Israeli military incursions into PA areas after 2002 and through until 2006 has left a devastated infrastructure, let alone the Israeli occupation closure policies which prohibit people commuting among Palestinian communities. After 2006 money has been spent as previously mentioned on rehabilitating the destroyed infrastructure and for providing the required facilities but without building the needed institutional and human capacities.

In the effort to describe the solid waste status in the PA, a survey study was conducted in 2002 and 2008 (khatib and Al-Khateeb, 2009) which showed that the daily average per capita generated municipal solid waste is in the range 0.5 - 0.9 kg. This average takes into account communities living in urban, rural, and refugee camps. It was found also that solid waste consists mostly of biodegradable organic waste, a characteristic that agrees well with studies done for other similar developing countries (El-Edghiri, 2002). Later in 2009 same characteristics were reaffirmed by the Palestinian Central Bureau of Statistics (PCBS) which further suggested an annual generated solid waste of one million tons in the PA area.

Due to the importance of the sector on the development process, the PA has in 2009 declared the solid waste management sector as a national priority and therefore, issued the guiding principles for the Palestinian ISSWM which are:

- The principle of sustainable solid waste management that ensures optimal use and protection of the environment,
- Clarity of roles and responsibilities and separation between regulatory, monitoring, and executive duties,
- Facilitated availability of information and the transport exchange among stakeholders involved,
- Transparency of institutional, financial, monitoring, and administration systems,
- Partnership based on integrity and clarity of roles of each stakeholder,
- Recognition of private formal and informal and NGO sectors,
- Transparency in dealing with public complaints,
- Principles of “polluter pays” and “Producer pays”
- Principle of self funding and providing services at reasonable prices,
- Principle of economy scale in planning and developing the services,
- Gradual implementation of initiatives technologies, and new models related to solid waste elements; i.e. reduction, recycling etc.
- Creating incentives to encourage successful practices,
- Compatibility of technology and facilities used in the solid waste management to local conditions and needs,
- Penalty system against parties that do not adhere to appropriate procedures in dealing with solid waste.

These guiding principles were considered in the prepared strategy and where impeded while defining the Palestinian ISSWM strategic objectives, which are:

- An effective legal and organization framework for solid waste services,
- Strong and capable institutions,
- Effective and environmentally-safe management of solid waste services,
- Financially viable and efficient management services and activities,
- Principles and mechanisms suitable for managing medical, hazardous and special wastes,
- More participating and aware community,
- Effective information and monitoring systems.

The implementation of the Palestinian ISSWM has been launched and hopefully the scenario which favors political stability will prevail to ensure the expected outcomes.

5. Conclusion

Developing and least developed countries have no alternative but to plan for a sustainable development processes acknowledging the importance of encountering the problems in persistence and facing the development challenges with an active participation of stakeholders including the public. With the growth in urbanization MSW services is becoming one of the most challenges which if not properly and sustainably dealt with will adversely impact all other development sectors. The best approach for dealing with solid waste sector is by implementing an integrated and sustainable management approach that ensures the good health of the society and the environment and the active participation of the society. An example of implementing the ISSWM approach has recently been initiated by the Palestinian Authority and if political atmosphere permits the adequate implementation of the ISSWM strategy feedback would be of most beneficial to many developing and least developed countries.

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