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Sustainable Solid Resource Management

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Abstract

According to the law of nature it does not make any waste. Remains of the activities of one living being is the food for another living being. When these remains are made into food for those living beings which produces harmful substances, it is called waste. Managing waste is never a sustainable model. Managing resource is a sustainable model. Humans are the only beings who are converting their remaining resources of various industrial, residential, commercial activities into waste. Human urban habitats are high population density areas with very low or no spaces left for vegetations to balance the input and output of various activities. Invention of non-biodegradable items also required a design which would bring it back to the manufacturing units as raw material. Failure to do so, by the inventors and the manufacturers, have triggered nature's such behavior which has created harmful substances, now we call it as pollutants. Substances which threatens the survival of the same beings who has generated it, is called pollutants for that being. Now the magnitude of the problem has become much larger because this failure of design has become a threat to other animals and plants. Contamination of underground water tables and generation of new sets of health problems arose. In order to overcome such problem, Sustainable Solid resource management is the only way out.

Key-Words: Solid resource, waste, Management, Ecosystem, pollutants , Urban habitats, recycling, biodegradable, non-biodegradable, sustainable.

1.Introduction

Solid waste management (SWM) is one of the most neglected aspects of India's environment and the recent municipal solid waste (management and handing) Rules 2000 have made it mandatory for the administrative authority of any area to undertake responsibility for all activities relating to municipal solid waste management (MSWM)[12]. A Survey of MSWM practices in Indian urban local bodies (ULBs) and the literature suggest that major problems in MSWM in India are : underestimation of generation rates and therefore ,underestimation of resource requirement ,lack of technical and managerial inputs , and lack of updated information to the public and practitioners in the field. To resolve this issue, cities and their citizens should join together to create sustainable lifestyle and an ecological civilization in which people and environment coexist in harmony. A literature review on the subject of solid waste management (MSW) is yet in the formative stage as a well classified and large quantum of information is not at hand. This paper summarizes the literature and inferences gathered so far pertained to the topic.

2. Purpose

The purpose of this literature review is to gain an understanding of waste management planning concepts, frameworks, strategies, and components that are current and emerging in the field. A particular focus is given to literature which pertains to municipal solid waste (MSW) and construction and demolition(C&D) waste with a greater emphasis placed on information useful to organizations in the industrial (ICI) sector. The main focus of this research paper is on the sustainability and financial aspect of SWM. Areas such as challenges facing SWM, Environmental Audit of SWM system , importance of public-private partnerships in SWM, financial performance analysis of SWM through Cost-Benefit Analysis are covered in this paper.

The consciousness of environmental degradation due to current solid waste management drives the communities to yearn for improvement initiatives. The study suggests that intervention by authority to introduce integrated and sustainable solid waste management is required. The crucial elements of a comprehensive waste management plan are examined in detail. Specific information is given on the characteristics of MSW, existing frameworks emerging trends, and important considerations. The literature review findings will be used in the development of an ICI waste management best practices guide for Nova Scotia. The literature review findings will aim to answer the following questions:

- What components are essential in a comprehensive waste management plan?
- What types of considerations should a NS-ICI sector organization contemplate in developing a waste management plan?
- What is the range of options of that exists in forming a waste management plan?
- End the “Use & Throw behavior of Humans” by information, education and communication. Design rewards and punishment system and implement it with the support from policies approved by the Supreme Court and National Green Tribunal.
- Refuse throwing, Restore & Reuse as many times as possible, then Recycle
- Create resource recovery rooms in every place of human activities. Change design on the table
- Start segregation of remains at the place of its generation
- Do door to door collection or process within ones’ own space
- Transportation to processing area
- Various processing plants which recycles the material in two forms.
    - A form which gets back to consumers hands for direct use
    - A form which gets back to consumer’s living space as energy, such as electricity, oil, gas (CNG)

3. Methods

The literature review focuses on surveying information pertaining to existing waste management methodologies , policies, and research relevant to the ICI sector in Nova Scotia. Information was sourced from peer-reviewed academic literature, grey literature, publicly available waste management plans, and through consultation with waste management professionals. Literature pertaining to C&D and municipal waste minimization, auditing and management were searched for through online journal database, particularly web of science, and science Direct. Legislation pertaining to waste management in Nova Scotia[31], and in Canada, was also researched using the Canlii database. Additional information is obtained from grey literature and textbooks pertaining to waste management topics.

After conducting preliminary research, prevalent references of selected sources are identified and scanned for additional relevant articles. Research is also expanded to include literature pertaining to recycling, composting, education, and case studies. Input from a sub-committee comprised of various waste management professionals identified areas requiring further research.

3.1 Waste Characteristics

A common misconception is that environmental protection and sustainable initiatives must come at the expense of economic development (El-Haggar,2007)[4]. This may be true particularly for managing waste, a process which depletes natural resources and pollutes the environment if not done correctly. Proper waste management can be costly in terms of time and resources and so it is important to understand what options exist for managing waste in an effective, safe and sustainable manner (El-Hagger,2007)[4].This is particularly true for organizations which falls into the industrial, institutional & commercial sector.

3.2 Solid Waste Generation

Waste generation is the most important aspect to look at in order to have effective solid waste management system. The generation of waste varies considerably between countries based on the culture, public awareness and management (Hazra and Goel,2009; Wagner & Arnold, 2008; Magrinho et al.2006)[30].Generally, developed countries generate more waste than developing countries generate more than developing countries (Kathiravale & Mohdyunus, 2008). Countries in Asian and African region produce waste in the range of 0.21-0.37 tons/ capital/year. While European countries generate higher amount of waste with 0.38-0.64 tons/capita/year.

Integrated sustainable waste management (ISWM) system was then introduced in 1995 to improve earlier system that neglect unique characteristics of a given society, economy and environment. For example- European countries had applied had applied various system assessment tools and engineering models to create sustainable communities, manage resources efficiently, tapping innovation potential of the economy, ensuring, prosperity, environmental protection and social cohesion in their SWM system (Pires et al,2011)[16,17]. Asian countries had also given attention in building the national legal frameworks, managing institutional, technology, operational and financial aspects. The waste management system should be dynamic and continuous based on new insights and experiences(van de klundert,1999). Thus, the improvement in policy is needed while it will also benefit the countries. As an ex, based from EU25 group, it was found that the generation of waste is increasing and is expected to continue for many years ahead. After implementation of the EU,s policy in waste recovery and incineration the amount of waste and filled has been decreasing slowly (Mazzanti & Zoboli, 2008)[11].Public participation and recycling in England. It is a comparison tool for study of behavior change.(Timlett,R.&Williams,2008)[24]

4.Waste Streams

The review of literature characterizes several waste streams mainly - Municipal solid wastes (MSW),Hazardous waste & Universal waste. Municipal solid wastes is oftenly considered as the waste that is produced from residential and industrial sources excluding the hazardous and universal wastes, construction and liquid wastes (water, wastewater, industrial process) (Tchobanoglous& Kreith,2002)[22].

In Nova Scotia, Municipal Solid Waste is defined through the solid waste-resource Management Regulations (1996)[15] which state that it includes garbage, refuse, sludge, rubbish, tailings debris, litter and other discarded materials resulting from residential, commercial, institutional and industrial activities which are commonly accepted at a municipal solid waste management facility, but excludes wastes from industrial activities regulated by an approval issued under the Nova Scotia Environment Act" (SWRMR, 1996)[16]; typically recycling re cycling, and garbage can differ by region, therefore organizations must ensure that waste is separated according to local area by-laws. A typical developing country like India has been facing the issue of safe and efficient handling of e-waste ever since the revolution in Information Technology. The availability and affordability of a whole range of electronic equipment couple with innovations and changing trends have ld to rapid rate of obsolescence. India is the fifth biggest generator of e-waste in world

(United Nations University,2014), currently around 15 lakh metric tons (MT) per annum e-waste is generated and its compound annual growth rate is about 25% (ASSOCHAM, 2014).[2] E-waste comprises around 7% of total solid generated in India (United Nations University,2014). Almost 60 per cent of e-waste is a mix of large and small electrical equipment used in homes and businesses. Indian Ministry of environment, Forest and Climate Change, notified e-waste rules which came into force with effect from 1st May 2012 .Implementation of EPR (extended Producers Responsibility) and mandatory registration of e-waste recycling firms with Pollution Control Boards are the key salient features of e-waste rules. Bangalore has over 1,200 overseas and domestic electronic industries, which pushes it in the list of cities facing the menace of e-waste hazard. Bangalore generates nearly 86000MT of e-waste per annum and has 31 registered e-waste recycling /dismantling firms (CPCB,2014) which only 3 are actively involved in recycling (Gupta & Shekar,2009). Trishriya ---one such firm, exports e-waste for smelting to recover precious metals to developed nations while the other two E-Parisara and Ash Recyclers are only limited to sorting, dismantling, and shredding (Gupta & Shekar, 2009). Informal sector in this trade has huge limitations when it comes to recovery of precious metals like gold .This sector usually recovers less than 20% and produce emission of precious.

Plastic Waste (Management and Handling) Rules, 2009:It deals with scientific disposal of plastic waste and extended producer responsibility clause has also been incorporate in it.

Hazardous wastes are substances which are potentially hazardous to human health and /or the environment. As such, they typically require special disposal techniques to eliminate or reduce the hazards they pose (Meakin,1992)[10].Hazardous wastes are handled differently across different provinces; however many provinces, including Nova Scotia, have adopted the federal Transportation of Dangerous Goods Regulation to manage hazardous wastes are typically classified by product type; however, it is important to consider that material properties and concentrations can impact the dangers and risks posed by certain materials (N.P. Cheremisinoff& P.N.Cheremisinoff,1995). Knowledge of the properties of certain materials and products is essential, but information on impurities, trace materials, and intermediate by-product may also be needed since they can be potentially hazardous in certain quantities or forms.

Planning Commission Report (2014)[18] indicated that 62 million tons of annual MSW generated in urban area can produce 439 MW of power from combustible component and RDE, 72 MW of electricity from landfill gas 5.4 million metric tons of compost for agriculture use as CH_4 has 23 times higher global warming potential than CO_2. The utilization of landfill gas, particularly CH_4 for energy production is important as it finally converts into primary constituents (i.e.CO_2 and H_2O) A study conducted by united Nations Environment Program (UNEP)has shown that green house gas emission from landfill can be significantly reduced by following environment sound management of hazardous and other wastes (UNEP,2008,2010):

Universal waste can be defined in a number of different ways. The United States Environmental protection Agency (USEPA) defines universal waste as a set of hazardous materials that is generated in a wide variety of settings, by a vast community, which is present in significant volume in nonhazardous waste systems (USEPA,2005)[25]. The USEPA restricts the definition to four classes of materials: batteries, mercury-containing equipment, pesticides, and lamps. In California, legislation defines universal waste as hazardous wastes which are generated by households and businesses (CDTSC,2010) that contain mercury, lead, cadmium, copper and other substances which are hazardous to human and environmental health (CDTSC,2007). In California, there are seven designated types of universal waste: Electronic devices, batteries, electric lamps, mercury-containing equipments, CRTs, CRT glass, and non-empty aerosol cans (CDTSC, 2010).Guidelines and regulations governing the handling and processing of universal waste are less stringent than hazardous waste regulations, thus allowing the hazards of

universal waste to be recognized while allowing for greater flexibility in processing and treatment than with hazardous wastes (CDTSC,2007;2010;2008; USEPA,2005). Universal waste can differ by region, but will generally possess certain characteristics such as:

-posing certain environmental or health risks rendering it unsuitable for processing and disposal through regular municipal solid waste streams;

-posing lower risks than designated hazardous wastes;

-being generated by a wide variety of people, businesses, and settings;(CDTC,2007;2008;2010;USEPA,2005)[26]

5. System Analysis

Systems analysis can provide information and feedback that is useful in helping to define, evaluate, optimize and adapt waste management systems (Pires et al,2010)[16.] There are two main types of systems analysis techniques relevant to waste management systems:

-Systems engineering models such as cost benefit analysis, forecasting models, optimization models, simulation models, integrated modeling systems

-system assessment tools such as management information systems, expert systems, scenario development, material flow analysis, life cycle assessment, risk assessment, environmental impact assessment strategic environment assessment, socioeconomic assessment (pires et al.,2010)[16]

6. Digram

7. Waste Management Hierarchy

The early 1970s could be considered as a turning point for waste management in Europe. The 1972 report to the club of Rome and the oil crises in 1973 drew attention to an issue of the scarcity of raw materials. These events induced the change in

In some instances 3R's methodology can be adopted. Some organization have chosen to add a fourth R (Concordia University,n.d.[3]; FNQLSDI,2008 UC Davis,2008; U of T,2008). The fourth R can represent different words including re buy (UC Davis,2008), rethink (Concordia university, n.d.; u of T,2008), and recover (FNQLSD, 2008). The concept of re buy refers to consumer purchasing decisions. Consumers have the ability to take steps to improve waste management by helping to close the loop in waste management systems by purchasing products which have been recycled or used (UC Davis, 2008). Rethink is added to the three R's by some because changing our behavior and our actions can lead to improvements in waste management. Changing consumption patterns and considering the impacts of our action can lead to decreased production of waste, and even a reduction in waste management and waste minimization efforts (Concordia University, n.d.).

Recover can refer to methods which use and process waste so that it is used rather than disposed of (which would include reuse and recycling); however it can also include recovering energy form waste before it is disposed. Waste can be processed into a fuel and used to produce a usable form of energy (FNQLSDI,2008).

These additional concepts do not need to be limited to 4 R's. El-Haggar (2007)[4] proposes that to achieve sustainable waste management, a 7R methodology should be adopted: Reduce, Reuse, Recycle, Recover, Rethinking, Renovation, and Regulation. Renovation refers to taking action to develop innovative ways to process waste, while regulation is added in recognition that it is a driving force behind ensuring the implementation of responsible waste management practices (El-Hagger, 2007)[4].

society's perception of the term 'waste methods of waste handling and necessary transitions in waste management (Kemp and Van Lente 2011)[8]. In 1979, a Dutch politician Ad Lansink developed a priority list for the various waste management methods, which became known as 'Lansink's Ladder' and became official policy in 1981 (Raven 2007).[19]

Today's waste prevention framework, which uses the 'Lansink's Ladder' as a protype, is wide used in various waste related areas such as legislation and numerous projects, initiatives and strategies. The current framework is a five-step hierarchy of waste management and waste treatment options ordered according to what is best for the environment (UK Department of energy and climate change and Defra 2011). However, in each particular case the hierarchy passes through "Modifications". Having waste prevention as a final goal, different expert groups and institutions adjust the waste hierarchy by extending or narrowing the content of its stages. In the US Environmental Protection Agency (EPA)[6-27]. The EPA works under the Resources Conservation and Recovery Act, primary law, which govern the disposal of solid and hazardous waste in the country. Under this law the EPA encourages practices that reduce the amount of waste prevention, recycling, and composting. The agency has ranked the most environmentally preferable options for waste management from "Source reduction" to treatment and disposal, with 'Recycling' 'Composting' and 'Energy recovery' between (US.EPA2012 b)[28]

Fig1-Waste management Hierarchy (U.S.EPA 2012b)

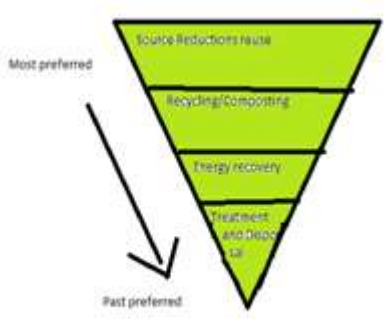

Fig 2 -Waste hierarchy (UNEP Division of Technology, Industry and Economics , International Environmental Technology Centre 2010)

A waste management hierarchy is also a framework used in the approach integrated solid waste management (ISWM). This strategic concept is used for managing all sources of waste: Prioritizing waste avoidance and minimization; practicing segregation; promoting the 3Rs (Reduce, Re-use, Recycle): implementing safe waste transportation; and treatment and disposal in an integrated manner with an emphasis on maximizing resource-use-efficiency (UNEP 2011)[27].

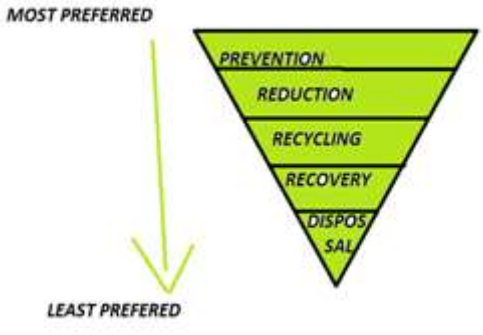

Fig-3 The waste management hierarchy (UNEP 2011)

Fig-4 The EU waste hierarchy (WRAP 2012)

However, based from the data from developed countries, the actual amount of waste been land filled is actually decreasing as more waste are incinerated, composted or recycled. Looking at the positive angle, Lomborg (1998)[9] believed that area needed is sufficient to cater the total amount of waste generated by the world, but the problem is the location since nobody wants to stay near landfills. He also reported that air from incinerators and groundwater near landfills today are cleaner and safer. Therefore solid waste generation can be considered more of a political or social issue than others (Lomborg-1998)[9].E-waste Management and Handling Rulers 2011 : It is applicable to stake holders associated with the manufacturing, handling, utilizing, processing, and recycling electrical and electronic-related waste items. Most researches emphasize that ULBs fails to implement these laws adequately. However, needs and aspirations of stake holders demands for appropriate the GOI is continuously encourages ULBs to implement these rules at ground level and recently draft notification fro MSW (Management and Handling rules 2015)[14] is also under formulation (Ministry of Environment, Forest and climate Change, 2015)[13].

A lot of literature has discussed current practices, challenges and future solutions on waste management such as those for India (Hazra & Goel 2009), Portugal (Magrinho et al.,2006) Canada (wagner& Arnold, 2008)[30] and Malaysia (Agamuthu et al, 2009)[1]. These studies allow comparison to adopt the best practice wherever applicable.

8. Conclusion

From reviewing the literature, it is clear that key management frameworks have evolved from a variety of disciplines from engineering to ecology. Some are more inspirational in form while others are process focused. The function and culture of the organization will help determine the appropriate waste management framework for an ICI organization. For example, an institutional environment would differ from an industrial setting which can differ from the commercial sector. In an institutional setting a wide-range of products are used creating large volume of a number of streams from hazardous to construction and demolition waste. Hundreds of people are involved in procurement and sorting waste at stations. In a setting like a university, each year there is a larger turnover of students. The need for constant education is pressing. Materials are used rather than created.

In an industrial setting, focus is on the creation of a product. The opportunity for waste efficiency and reuse is more streamline and perhaps easier to control with less individual actors. The diversity of the stream may be comparable to the ICI sector. In a commercial setting, the diversity of the stream may be less but individual actors may be of a similar nature to the institutional sector. Given the difference in the nature of the sector and actors involved, the application and suitability of some waste management frameworks would differ by sector. This is reflected in examples such as government switches from zero waste to indicator-based frameworks.

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