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An approach to tackling the environmental and health impacts of municipal solid waste disposal in developing countries

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Abstract

Indiscriminate disposal of municipal solid waste in developing countries poses severe environmental and health threats. The study proposes a new method for dealing with these problems. The hybrid structural interaction matrix (HSIM) was used to prioritise major identifiable environmental health factors arising from improper solid waste disposal. The simplistic resource allocation model was adopted to ensure optimality in the allocation of resources to prioritised factors. The study indicates that tackling environmental health impacts from the most prioritised negative disposal factors through optimal allocation of resources, will either reduce or eliminate the impacts associated with subsequent less prioritised factors that are direct consequences of the highly prioritised negative factors. The method proposed will aid decision makers in knowing which set of systemic factors are to be given preference and to what extent at given periods in time.

Keywords: Municipal solid wastes; Waste disposal; Hybrid structural interaction matrix; Resource disbursement; Prioritisation

1. Introduction

The 21st century has experienced heightened economic activities due to the industrial civilisation that has characterised countries worldwide. Ziadat and Mott (2005) note that the progression of modern civilisation and associated continuous increase in population worldwide contribute significantly to the increase in the quantity and variety of waste generated. The ever-increasing consumption of resources results in huge amounts of solid wastes from industrial and domestic activities, which pose significant threats to human health (Frosch, 1996). Sangodoyin and Ipadeola (2000) state that the simple nature and relatively small volume that characterised waste in the past have been changing with the advent of industrialisation and urbanisation. Continuing advancement in science and technology is also, contributing significantly to the increasing volume and toxicity of waste generated (Sangodoyin and Ipadeola, 2000). For example, advancements in aviation technology have led to an increasing number of people patronising airports and airline services. Consequently, the aviation industry worldwide has a reputation for being a major polluter with airports perceived to have negative environmental effects in terms of waste production (Pitt et al., 2002).

Wastes are usually classified into different categories such as biodegradable (i.e. decomposable wastes) and non-biodegradable (i.e. non-decomposable wastes). Further classification based on source could be categorised as municipal (residential and commercial), industrial, and construction and demolition wastes. This paper focuses on municipal solid wastes.

The generation of wastes is not the contention but the disposal of generated wastes. The threat posed by inappropriate disposal of waste in the developing world could be readily observed in the streets of towns and cities that are littered daily with wastes. The campaign against

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indiscriminate waste disposal also seems to have lost its substance in many parts of the developing world. For instance, improper disposal of organic solid waste has serious environmental and health consequences. Such practices contribute to widespread environmental pollution as well as the spread of diseases (Gulec et al., 2001).

Many experts have expressed grave concerns about improper waste treatment and disposal. Townsend et al. (2004) considered the implications of leaching of CCA-treated wood for waste disposal. Other scholars have suggested various measures for waste treatment, including recycling, sanitary landfilling and incineration to produce energy (Hjelmar, 1996; Dijkgraaf and Vollebergh, 2004). Some positive achievements have been made in the design and implementation of waste disposal systems, such as the design and construction of sanitary landfills (Bacon and McGrail, 2003). In some developing economies, a change of attitude, from dumping of wastes in inappropriate places to its economic utilisation through adequate treatment and processing is advancing. Sangodoyin and Olorunfemi (1996) reported the use of livestock wastes on small-cultivated plots in Nigeria for economic utilisation of their nutrients. However, Laughlin and Varangu (1991) criticised governments for not giving much attention and incentives to investors in waste disposal systems. The authors stated that in many developing countries, governments have traditionally supported and encouraged mining, logging, and the extraction of petroleum-based products, through a series of favourable policies. However, industries that refine and recycle secondary materials do not have the same favourable tax incentives available to make their activities cost-effective.

The ills of inappropriately disposed municipal solid wastes are quite numerous to be mentioned. Health deterioration, accidents, flood occurrences, and environmental pressures are just a few of the negative effects. Other environmental effects also include pollution of surface and underground waters, unpleasant odour, pest infestation and gas explosions. The perils associated with inappropriate solid waste disposal, and associated environmental health impacts should therefore be of utmost concern to waste management experts (Themelis, 2002). If waste pollution persists unchecked into the future, it may lead to unprecedented health casualties.

The World Health Organisation (WHO), governments, local health authorities, waste planning and disposal authorities have over the years set standards and laws regarding municipal waste disposal. These include; (i) legislations relating to hazardous wastes; (ii) pollution control which sometimes requires a licence from environmental protection agencies before "controlled waste" could be disposed in landfills or incinerators (Wills, 1995); (iii) Environmental Protection Acts (EPA) (Wills, 1995); (iv) and the principle of polluter-pays that requires a polluter to finance the collection and disposal, or treatment of its wastes (Geraghty, 2003).

These standards and laws have not been effectively implemented, particularly due to inadequate management capabilities and misappropriation of resources. The problem is further compounded in the developing world where due to poverty individuals and organisations pursue survivability rather than environmental improvement. As a result, it is common to see heaps of landfills scattered around places of domicile with severe environmental impacts. Programmes such as; (i) creating awareness and conducting training on municipal solid waste prevention; (ii) public education programmes on recycling and composing of municipal solid wastes; (iii) purchase of equipment or materials to initiate or expand the recovery or processing of recyclable materials; and (iv) preparation of municipal solid waste management plans are often lacking. The paper examines environmental and health effects of inappropriate municipal solid waste disposal using the hybrid structural interaction matrix (HSIM) approach (Oke and Ayomoh, 2005). A resource allocation model, which is primarily dependent on the weight value of each factor, that is, a representation of their priority ordering was also incorporated to devise a measure for allocating resources to identified disposal impacts.

2. Methodology

The HSIM concept presents a new way of examining the environmental health implications of municipal solid waste disposal, by integrating a weighted factor that enables numerical analysis of ranked factors. The application of the HSIM concept enables the formulation of dynamic models in resource allocation. This provides a useful tool for resource decision making, similar to other applications in areas such as water resource planning (Hyde et al., 2005) and data mining principles applied in the simulation of resource allocation plans on farms (Ekasingh et al., 2005). Another similar tool is the use of multi-objective optimisation approach in resource allocation (Xevi and Khan, 2005). The HSIM has been successfully tested in manufacturing systems, particularly in maintenance resource planning systems (Oke and Ayomoh, 2005), and in prioritising safety engineering resources (Ayomoh and Oke, 2006).

In this study, some identifiable environmental health impacts associated with improper municipal solid waste disposal practices in developing countries were identified, prioritised and weighted in importance, depending on the number of subordinate factors attached to a factor. The simplistic resource allocation model was adopted in allocating resources to the identified factors based on the computed normalised weight of factors. The purpose is to ensure optimality in resource allocation in respect of the priority ordering of the factors. The HSIM concept thus proposed in this study, adopts a root-cause approach to dealing with environmental health impacts of municipal solid waste by allocating more resources to the most important negative environmental effects that arise from inappropriate waste disposal.