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# Integrated Solid Waste Management: A System Approach

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## ABSTRACT

*Increasing generation rate of waste became a challenging issue for many countries in the world. Need for sustainable waste management is inevitable because climate change and environmental degradation is associated with it. Globally, there is a pressing need for sustainability and minimum utilization of resources. Waste creation is an indispensable part of every human society. In inception, motivation behind the solid waste management is to decrease the hazard to public health and later the environmental attention turned into a fundamental concentration of SWM. In 1996 the United Nations Environmental Programme (UNEP) explained 'integrated waste management' as 'a framework of reference for designing and implementing new waste management systems and for analysing and optimising existing systems'. It is a challenging process to develop and implement sustainable solid waste management in developing countries. Integrated waste management approach is based on 3R approach (reduce, reuse and recycle). In current scenario, various material and energy recovery technologies are developed and incorporated in present framework. Sustainability improves if waste management is integrated to other system. The information provided by this article is very important for planning and implementing waste management system in cities.*

**Keywords:** Integrated Waste Management, Sustainable, Holistic Approach, Systems Approach, Complexity, Waste Hierarchy

## 1. Introduction

Municipal Solid Waste Management is complex problem with multiple dimensions and challenges in developing countries due to increased economic activities and rapid growth of urbanization. Municipal Authorities are responsible for providing efficient and effective waste management system to the inhabitants but they have faced challenges to tackle waste management issues due to financial constraint, organization and complexity of system. Simple solution to solve the growing problem of waste management is not appropriate as the society has become more progressive so there is an immediate need for strategies to curb this ever-growing problem of waste in such a way that municipalities can efficiently and effectively handle the increasing and changing quantity of waste. An effective management of solid waste needs incorporation of four elements: environmental, economic, social and governmental. Integrated waste management covers all these components and could be prove the most effective and sustainable option for developing countries to deal with the problem of waste. This paper aims to explain the concept of Integrated Waste Management as a systems approach.

## 2. Need for Systems Approach in Waste Management

System thinking to waste management was developed by W.R. Lynn in 1962 (McDougall, White, Franke & Hindle, 2008). This thinking was defined as 'viewing the problem entirely as an interconnected system of component operations and functions' so examined the entire complexity of waste management system (McDougall et al., 2008). System approach and

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mathematical modelling were essential to optimise waste management process and strategy formulation was the beginning step on the road to the term Integrated Waste Management. Waste Management is a complex issue which needs applicable technical solutions, adequate institutional capacity and integration between different stakeholders (Marshall &Farahbakhsh, 2013).One framework to sustainability is proposed by *industrial ecology*-a framework for shifting industrial systems from a linear model to a closed-loop model that is similar to the process of natural ecosystems. In natural ecosystem, there is zero waste, since one living being's waste turn into another's nourishment. Thus, industrial ecology gives base for re-examine traditional product or process technology and exploring innovative methods for recovery and reuse of waste streams (Fiksel, 2006). The U.S. Environmental Protection Agency's (EPA) Office of Research and Development is now embracing systems thinking of environmental sustainability. A system is an arrangement of interdependent elements or sub-systems which connect with each other in some way to complete some function. The properties of a system are characterized by the entire of the subsystems, their attributes, and the connection between them (Pires, Martinho, &Chang, 2011). The systems approach tries to consider all the individual sub-problems instead of confining itself to a single aspect (Haynes, 1981). Environmental and economic sustainability are the main goal of IWM. To achieve environmentally and economically sustainable waste management needs systems thinking for this purpose (McDougall et al., 2008). Traditional waste management system based on reductionist approach, failed to handle complexity, interlinked systems and their components. System procedures, such as waste generation, collection and disposal activities, are examined independently, though each is connected and influenced by others (Seadon, 2006). Many researches in SWM sector expose prosperous demand for SWM framework that identify the social, cultural, environmental, and political dimensions; that incorporate all stockholders; that view the whole system through holistic and integrating approaches(Dijkema et al., 2000; Henry et al., 2006; McDougall et al., 2001). Holistic thinking provides three main utility:

1. It gives overall view of the waste management process. That view is significant for strategic planning. It is very challenging task to handle each waste operation separately.
2. It focuses on entire environmental impact of the system.
3. It views extensive boundaries of the entire framework. It makes easy to decide if the entire framework runs efficiently and whether it could process at breakeven

## 3. Integrated framework as a system approach for Sustainable Waste Management

The concept of sustainable development is the outcome of growing awareness of world towards environment. The most generally used and acknowledged definition of sustainable development is that given in the report of the Brundtland Commission, Our Common Future Sustainability or Sustainable Development has been defined as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987).Sustainable development may be defined as procuring environmental, economic, and social welfare for present and future generation (Azapagic , 2004). In the context of waste, sustainability might be defined by fulfilment of following characteristics:

1. Environmentally effective
2. Economically affordable
3. Socially acceptable

Sustainable waste management also involve efficient use of resources, stable economic growth, protection of environment and socially acceptable (Powrie & Dacombe, 2006). Financial affordability and societal acceptability are two variables that must be balanced in deciding the SWM solution (Shekdar, 2009).Sustainable waste management must be integrated, market oriented, flexible and socially acceptable (McDougall et al., 2008). Sustainable practice of waste management is the underlying objective of Integrated Solid Waste Management (ISWM) through maximum utilization of resources. Solid Waste experts recognized that perfect approach to reduce the burden on disposal systems is to lessen the quantity of waste that is generated. The modern solid waste management gives focus on reduce, reuse and recovery before disposal. These three words are at the focal point of the discourse of integrated waste management. Reduce is utilizing the fewer disposable products. Reuse is utilizing the products again after their initial buyer utilize in past. Recovery is reclaiming the material or energy value of the product after use (Heimlich, Hughes, & Christy, 1992). UNEP gives assistance to cities for developing and implementing ISWM based on 3R Approach. Solid Development of ISWM would not only focus on integration of technology but also on all the policies and programs that are essential for effective management of waste.The term 'Integrated Waste Management' is characterized as a framework that adopts a systems approach and manages a wide range of solid waste materials and all sources of solid waste (McDougall & Hruska, 2000). Integrated Waste Management is multi-dimension approach which promotes sustainability and save resources in the end. Participation of all the stockholders including waste generators, waste processors, government and non-government organization and financial institution are the critical variable for the sustainable waste management.In the simple words, integrated waste management integrates waste hierarchy given by UNEP. The term integrated waste management can be defined in various ways but generally it is defined as the selection and utilization of relevant technology and management strategy to accomplish defined goals and objectives (Shekdar, 2009). To mitigate environmental impacts and reduce the cost, the system should be integrated (in waste streams, treatment and disposal methods), market oriented (output has end uses) and flexible, likely to change overtime for improvement(McDougall et al, 2008).It has been broadly realized that waste management system that neglect to incorporate social factors and preferences are bound to get failure. Effective waste management system requires stakeholder integration and empowerment, decision tranparency, networking, co-operation, communication, and accessbility of information (joos, Carabias, Winistoerfer, & Stuecheli, 1999).

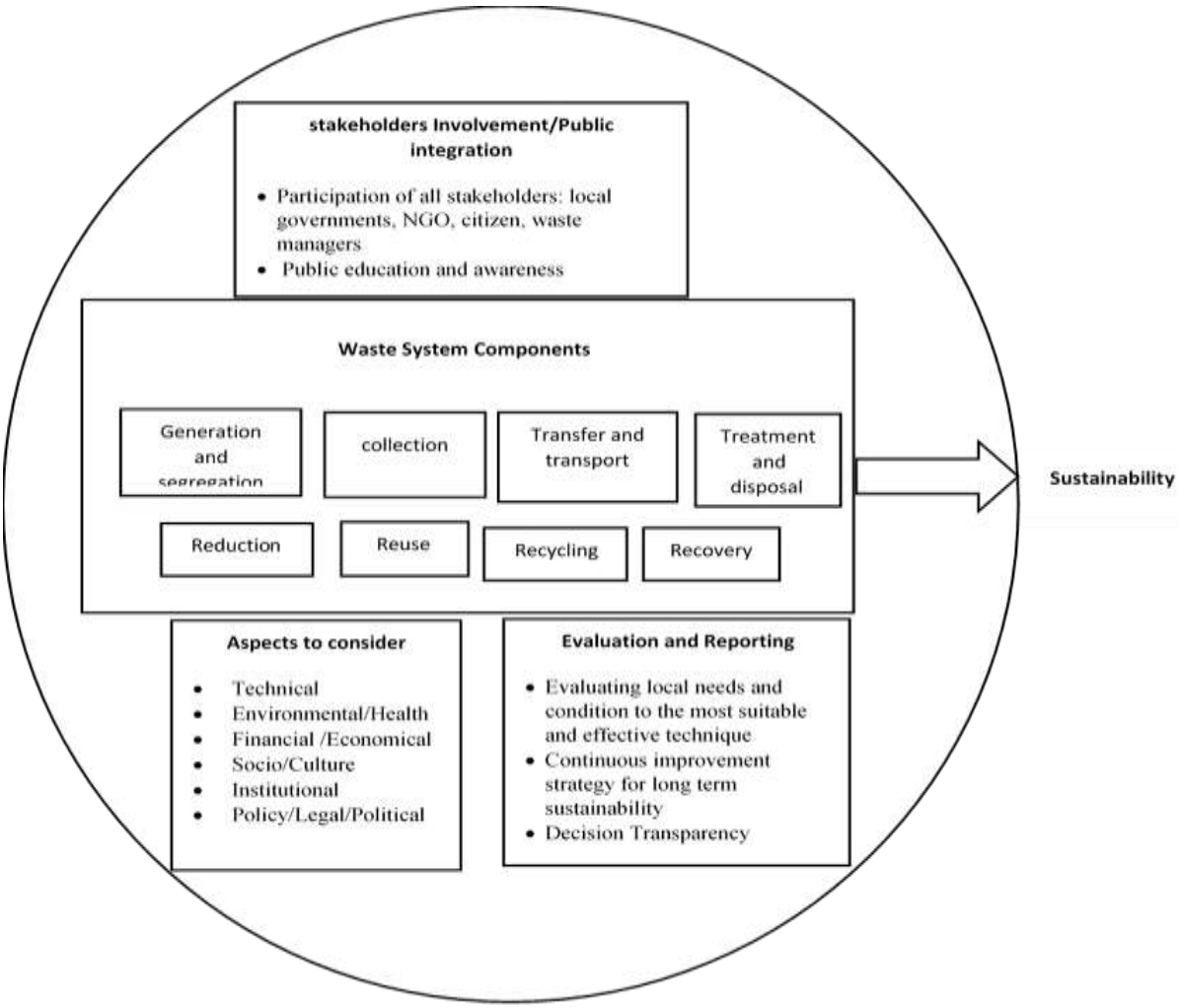


Figure-1
Integrated Solid Waste Management Model (Source: Marshall & Farahbakhsh, 2013)

## 4. Implementing Integrating Waste Management

Local and central government play crucial role in creating suitable environment for IWM by enacting appropriate policies and regulations. Planning and implementation of IWM for given region needs different steps, integrating all the major stockholders. ISM approach needs logical framework established on reliable baseline data to cover every phase of waste management stream.

These steps involve:

1. To compile and analyse data for creating baseline information on the characterization and quantification of waste from various sources with future trends.
2. Setting of goals by local government in participation with local stockholders for IWM.
3. Listing of problems associated to local stockholders including financial, technical, environmental, and social dimensions of IWM.
4. Framing of plan with element of management system including policies, technologies (and voluntary measures)
5. Establishment of an operational strategy for IWM.
6. Develop controlling and feedback tool.

## 5. Conclusion:

Sustainability is well known word today. This article comprehends the emerging concept of IWM based on systems thinking. ISWM is an evolving approach in which a model is considered in an integrated way which encourages waste generators to utilise their waste streams more efficiently than simply the disposal choice. A systematic effort is required to improve various components, including policy and legal frameworks, institutional arrangements, financial affordability, applicable technology, stakeholder's participation and awareness of IWM system.

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