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Land use based modelling of Solid Waste generation for Sustainable Residential Development in Small/Medium Scale Urban Areas

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Abstract

Municipal solid waste management has become a serious concern in India, and for efficient management, it is important that accurate methods are developed for estimating solid waste types, quantities and its distribution. Objective of this research paper, which is based on a HUDCO funded project, is to understand how residential land use and associated activities' based specific key generators of solid waste in a small/medium scale urban area are related to the quantity of waste generated and thereby to model the same. The study is aimed at deriving a more rational method to estimate quantity of solid waste generated type-wise, in place of the per capita based en-bloc estimation system practiced at present. Criticality of residential land-use and related generators are identified through a Delphi/AHP based expert survey process. Their relationship to waste generation is established based on the field survey conducted in 2 select wards of three cities namely Thiruvananthapuram, Coimbatore and Kozhikode in South India. The sample size was 150 households/ ward.

The results show that when solid waste estimation based on land use parameters is attempted for residential land-use, not only factors like household size, and income matter but also factors like housing typology, floor area of the residence and lifestyle of the family etc. have a decisive role to play. In its results part, the paper presents models for estimating solid waste for residential land-use based on the critical generator parameters with established correlation. Then the paper discusses the survey based validation results of the models. In conclusion, the paper briefly outlines a system that can be developed to estimate solid waste generation at an appropriate level with superior quantitative and qualitative precision of waste estimation. It can have immense application in waste management related capacity building and in formulating suitable policy guidelines.

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1. Introduction

Municipal solid waste management has become a serious concern in most of the developing countries in recent time [Erdogan, R., et al, 2008 and Glawe, U., et al, 2005]. As per the United Nations' conference on environment & development in 1992 (Agenda 21) environmentally sound solid waste management must go beyond the safe disposal of waste and be focused on minimizing the waste and maximizing reuse and recycling of waste[3]. In order to achieve this aim it is mandatory to know the generators of the municipal solid (preferably from a landuse perspective) and the rationale and logic concerned, as it can give directions on the quantity and type of solid waste generated and required capacity building. Broadly land uses of municipal solid waste generation potential are residential, industrial, commercial, institutional and agricultural land uses, and construction and demolition process. In this paper, for the landuse of residential, using a logical framework, generators of solid waste are explored, and using the ones with maximum correlation, models for estimating waste quantities are formulated and their efficacy is validated.

The per capita based system of waste estimation is followed in most of the urban areas in India. However, this system may not be an appropriate method of waste estimation in the Indian context, with increased population densities with widely varying characteristics decisive in generating solid waste and the urban growth being irregular and unplanned. Such a system works better for urban areas which develop in a planned manner based on a prefixed density of population. This system of assessment does not connect waste generation to the core activities that make up the waste creation, the socioeconomic background of such activities or the built environment grade/quality of the setting in an explicit manner for an urban area. Whereas, in the actual case, as has been seen subsequently, the stated aspects have a serious bearing on the quality and quantum of waste created. Land use and associated activities is a major umbrella entity to encompass all the stated aspects. A system that aims at identifying solid waste generators from such a perspective can be a considerably superior and accurate method for realistic assessment of solid waste and the project attempted this. The paper presents the case of residential land use related generators as identified through a Delphi process and refined through an expert survey process and how they perform in the case of select study area city contexts in generating waste. Based on the field survey data, for bio degradable and non bio degradable waste, separate models are worked out and discussed.

2. Research Objectives

Role of an effective solid waste management system is realized as an issue of paramount importance world over and it is found that uncollected and improperly handled solid waste can cause serious health hazards. In India, Municipal Solid Waste (Management & handling) Rule, 2000 stipulates that all local bodies should undertake segregation of waste and its collection, storage, transportation and disposal in a comprehensive manner. However, most local bodies could not comply in time as they lacked systematically evolved waste data under the stated heads. As planning and local self-government bodies formulate master plans and other vision documents with due reference to land uses such as residential commercial industrial etc. of various types and classes, the proposed paper and the models it propose will help to look at the solid waste estimation, management and infrastructure and capacity building from this point of view. However, the methodology is structured so as to capture other extraneous factors of influence apart from the landuse as well. The objective of this research paper is to understand how residential land use and associated activities' based specific key generators of solid waste in a small/medium scale urban area are related to the quantity of waste generated and thereby to model the same.

3. Past Work

Compared to western contexts, municipal solid waste from India differs greatly in composition with respect to its organic and hazardous nature of constituents [Gupta., et al, 1998]. Relatively high percentage of organic matter in municipal solid waste of Indian cities has a direct link to the cities' socio-economic status. It is also true that the higher the socio economic status, the lesser the organic matter within the generated solid waste. But when we look at the total quantity of municipal solid waste generation, metropolitan cities with a higher socio-economic status generate more solid waste than small and medium towns [CPCB., 2004]. Although it is an established fact that the quantity of municipal waste generation has a direct link to the socio economic status of a given area, root cause of