Abstract

In this study the average solid waste generation, its storage ability, its characteristics, optimum solid waste collection points and route planning for solid waste collection, transfer and transportation, with optimum resource allocation for the Colombo Municipal Council area have been looked into. Further a cost comparison has been carried out for allocating both human resources and machinery and equipment in solid waste management functions in Colombo Municipal Council and norms on the above functions have been investigated and presented in this report.

As solid waste generation is a function of socio–economic factors, cultural factors and population distribution & variations (migrant population), the per capita waste generation and its composition varies from country to country. It also varies from district to district as well as area to area due to same reasons. Further due to variation in climatic conditions and the factors mentioned above, the in-house solid waste storage ability varies from region to region. In order to establish the characteristics for the garbage generated in Sri Lanka, a series of investigations and analysis have been carried out on garbage samples of different categories (residential, commercial, restaurants, other institutions and parks etc). The maximum storage periods of the generated garbage for each of the categories and the variation in composition and the per capita garbage generation for these categories have also been analyzed Thereby it

was found that the maximum storage period for the garbage generated by each of the above category range from 2 to 4 days depending on the composition. Thereby the collection frequencies of the generated garbage for each of the categories have been established, according to the volume generated and ability to store this garbage.

A cost comparison was also done on the residential collection frequencies of 2 times and 3 times per week, for the Havelock Town ward. And it is revealed that the collection of 3 times per week is more economical due to the cost saving of 18% with a manageable waste storage period.

The waste contains of very high organic component. It was found that, in residential garbage, as the income moves from high to low the organic component increases and plastic, paper and metal component decreases.

The per capita garbage generation varies considerably, not only from district to district, but also within the district and this is mainly due to the variation in floating population. The average gross daily per capita waste generation for the City of Colombo is 0.76 kg in 1977.

It was also revealed that the residential per capita waste generation varies according to the income group. The low-income per capita waste generation was estimated as 0.49 kg/per day and the high income per capita waste generation as 0. 63 kg/day. The average per capita residential collection has

been found to be 0.55 kg/day for the CMC area.

The collection, transfer and transport aspects of solid waste management have also been looked into in this study. A study done on finding the appropriate point of collection has been performed and it has been found that the most viable point of collection of solid waste in semi residential areas is the curb/entrance and back yard or station collection is not suitable for low rise buildings. But for places where a large amount of garbage is collected such as markets, flats, hospitals, schools, large buildings, departmental stores and production oriented industries, the station collection is recommended. And also at the places where the compactor trucks are not accessible, waste collection by hand carts or station collection in appropriate locations is recommended. Level of public cooperation is also noted to be a vital aspect for improving both the resource allocation process as well as the efficiency level at which the collection and transfer process of solid waste management takes place.

Appropriate types of bins placed in public places will help reducing the scattering of litter and thereby increasing the efficiency of waste collection. On the other hand, placing the larger bins of capacity of 1 cu.m. or higher, at unwanted places will encourage the station collection. And therefore in the areas where the curb collection takes place only a minimum number of bins should be placed in order to maintain the aesthetics.

A cost comparison for both labour and machinery has also been done and it was revealed that the most practical number of labourers that must be attached to a vehicle is four.

The variations of the actual loads carried and the design loads of the solid waste transportation equipment have also been analyzed in this study. It was found that practically there exists a variation between the actually carried loads and design loads of the equipment. It was observed that on average the small compactor truck of 8 cu.m capacity is over loaded and the compactor truck of 12 cu.m. capacity is under loaded leading to uneconomic usage of the equipment.

It has also been revealed that the 8 cu.m. Compactor truck is the most economical when considering the cost of collection and transportation of solid waste. Considering the conditions of Sri Lanka including climatic conditions, the 8cu.m. compactor truck with a design capacity of 4500kg, higher ground clearance and a larger leachate collection tank capacity would be the most suitable compactor truck. The next alternatives in sequence are found to be the 12 cu.m. compactor truck and the tractor.

All elements of route balancing and micro routing, which are functions of route planning have been analyzed practically during this study, in order to allocate available resources optimally for collection and transportation of solid waste.

Public cooperation is an essential requirement in solid waste management and in order to get their cooperation they should be informed of the collection dates and times properly. Hence a route planning exercise and thereby a public awareness programme is essential. Route planning should be a continuously improving exercise with the public and worker cooperation. And regular updating of public of the collection dates, times and storage methods etc., (by means of pamphlets, newsletters) will increase the public corporation and in turn reduces collection time. Further this will help improving the aesthetics of the environment and also reduce the cost of solid waste collection and transportation.

And also route planning should be designed such that all the equipment available are properly utilized, i.e. loaded to design capacity, at the end of the each route in a minimum time for a particular frequency of collection.

The total time taken for a collection cycle per trip has been investigated for the Havelock Town area. Thereby the average time taken for each event and the optimum crew size has been calculated. Markets, flats, hospitals, schools, large buildings, departmental stores and production oriented industries are places, where large bins have been recommended for daily removal. The optimum number of trailers to be accommodated per tractor and skip bins per skip hoist has also been investigated. And it is recommended to have at least three trailers per tractor (in order to park the trailer at collection points) or /

and five skip bins per skip hoist depending on the distance/traveling time from the large bin collection point to the disposal site.

For tree cuttings, debris and desilting of drains, it is recommended to have a separate crew and that they cover each area at least once a month. It is also recommended that for collection of recyclable materials such as paper, polythene, plastic, glass etc., a separate crew, either direct employees or indirect collectors (may be from informal sector or NGO) is allocated and that they cover each area at least once a week.

An equation has been developed to calculate the feasible number of premises to be collected per vehicle per shift, for any semi residential area in order to optimize the capacity of waste transportation equipment. This equation could be used for route planning in any location with similar characteristics.

The norms for road sweeping, road brushing and poster removal by machine have also been established and are also presented herein. The norms for road sweeping have been found to be 750 square meters per laborer per hour. Similarly the norms for road brushing have been found to be 350 square meters per hour per group of 5 persons and for poster removal by machine to be 60 square meters per hour.