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Modeling indigenous Footpath and Proximity cut-off Values for Municipal Solid waste Management: A Case Study of Ilorin, Nigeria

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Abstract

Indigenous footpaths have been the major means of passage from origin to destination before the advent of cars and town planning. Over the years, these traditional areas have retained their original attributes with additional walking links to the motorable roads. In this study, footpaths to municipal solid waste bins were modelled in order to locate waste bins within an area in Ilorin, north central Nigeria. A network dataset was built in a standard GIS application (ArcMap 10) from the downloaded satellite image of the study area. The Location-Allocation tool in the Network Analyst window was then used to determine the optimal location of facilities based on cut-off walking distance which defines command area of a waste bin. The result of this analysis could act as a decision support tool for the determination of type, size and removal frequency of each waste bin based on estimates of waste generation from each command area.

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Introduction

Migration to cities and urbanization is a change that is taking place in almost every part of the world. Urban population is continually on the increase and population upsurge coupled with changing lifestyle has led to the generation of huge amounts of solid wastes in urban centres. Municipal solid waste management is the most important service a city provides especially in low-income and middle-income countries and a city that cannot

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effectively manage its wastes can hardly ever provide other vital social services such as healthcare, education and transportation (World Bank, 2012). More importantly unmanaged wastes have health, socio-economic and environmental impacts on the society. In fact solid waste is one of the five topmost challenging problems for city managers perhaps because it is a reflection of the quality of governance and a definite vote-loser if unmanaged (UN-Habitat, 2010).

The increasing solid waste generation rate, high management costs, and lack of understanding of factors that affect the different stages of solid waste management and linkages between these functional elements are some of the problems faced by municipal authorities in developing countries (Guerrero et al., 2013). Residents on the other hand have insufficient storage facilities for generated solid wastes and collection operation by the municipal authority is equally limited. It is documented that developing countries spend 20-50 percent of their regular budget on solid waste management, yet 30-60 percent of urban solid waste is uncollected and less than half of the population is served (World Bank, 2011). In particular, low service coverage may be attributable to the spatial structure of some cities and the existing link between solid waste generators and managers.

It is obvious that human settlements in cities evolve from a primitive society of unplanned hamlets with specific attributes. The spatial structure of large cities today is such that they originated from traditional core areas of old cities which are characterized with footpaths, narrow roads and haphazard settlements. Over the years, these traditional areas have retained their original attributes with additional walking links to the motorable roads. Indigenous footpaths have been the only means of passage from one location to another before the advent of cars and town planning. Consequently, walking along footpaths has become the main mode of transport in most societies, particularly for short trips involving access and egress to the main mode (World Bank, 2002). Therefore planning for public facility location must take into cognizance the spatial structure of the society and the major mode of movement of inhabitants.

Spatial information is indispensable for numerous aspects of urban planning, development and management (FIG, 2010). Geographic Information System (GIS) is a powerful tool for spatial modeling of various systems covering several aspects of interest. GIS has thus found wide application in several spheres of human endeavor. Recent improvements in GIS technology has made efficient management of solid waste in several ways such as data management, estimation of municipal solid waste generation rates and service coverage, location of pick up points, transfer stations and disposal site, location -allocation of waste bins, vehicle routing and scheduling, and route design. Spatial modeling in GIS.

During the last two decades, planning processes involving public facilities is increasingly more complex and facility location models are among the indispensable decision-aid tools (Teixeira and Antunes, 2008). These models are used to find optimal or near optimal locations for activities that service some kind of demand distributed in space. The objective is usually to minimize or maximize certain variable(s), or conform to a pre-specified performance standard before locating the facility (Miller and Shaw, 2001). A variant of the facility location model is the location-allocation model which obtains the best location for a facility as well as assigns demand points to the facility based on criteria such as distance, time, and cost. Such location-allocation model provides a framework for investigating service coverage, analyzing and comparing location based decisions, and generating more efficient alternatives (Rahman and Smith, 2000).

In reality, indigenous footpaths in developing countries are perhaps the shortest route traversed by pedestrians to their destination. Non-inclusion of indigenous footpaths may give misleading results of distance impedance during location-allocation modeling of solid waste bin. Based on the above, the objective of the present study is to develop a GIS based location–allocation model for solid waste estimation and optimal location of waste bins considering the indigenous footpaths.