UNIVERSITY OF NAIROBI

APPLICATION OF GIS IN SOLID WASTE COLLECTION: CASE STUDY OF NAIROBI CBD

BY

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OUTLINE OF PRESENTATION

- Background information
- Problem statement
- Objectives
- Case study
- Tools
- Data resources
- Methodology
- Results and analysis
- Conclusion and recommendations
Definitions

• Solid waste is the useless or unwanted material arising from various human activities, normally solids or semi-solids.

• Solid waste collection can be defined as the transfer of solid waste from the point of production to the point of treatment or landfill.

• Illegal dumping involves discarding solid waste in a location other than at a recycling center or permitted disposal site.

• Solid waste collection point in this study is used to refer to a point of temporary storage of solid waste resulting majorly from street sweeping and also direct dumping from points of generation.
Background Information

• Increase in trade activities in the CBD has led to increase in solid waste production. This has led to a great challenge in solid waste collection.

• There is need for effective and efficient solid waste collection information system.

• To achieve this, optimal location of solid waste collection points is essential.

• There is need for an efficient solid waste collection information system.
Background Information

- Solid waste collection in the CBD is under the Department of Environment, in Nairobi City council.
- It involves two major activities namely, litter collection and its transportation.
- Litter collection entails street sweeping and collection using litter bins.
- Waste from street sweeping is moved manually to collection points using wheeled bins and/or wheel barrows.
- Collected waste is transported from collection points and litter bins to the main dumpsite, located at Dandora, in Nairobi.
Problem Statement

• Solid waste collection points are inequitably distributed and inadequate.
• There exist numerous illegal dumpsites in some zones in the CBD.
• Inappropriate solid waste collection information system is also a challenge.
• Poor spatial and non-spatial data linkage.
Objectives

Main objective

• To create a geo-database that will enable storage and management of solid waste collection data and carry out spatial analysis to determine the suitable sites for location of collection points.
Specific objectives

• To identify and map the spatial distribution of the existing collection points.
• To identify and map illegal dumpsites in the CBD.
• To create a geo-database of spatial and non-spatial data on solid waste collection aspects.
• To carry out suitability analysis to determine suitable sites for location of collection points.
Area of Study

• The area of study is the Nairobi Central Business District (CBD). Nairobi is the capital city of Kenya.
• It is located within 36° 48’ East, 1° 16’ South and 36° 50’ East, 1° 17’ South.
• It is divided into seven zones namely zone 1 through zone 7.
The Area of Study
Tools

• **Hardware**
  - Computer with specifications of 250 GB memory, 2GB RAM and 2.20 GHz of speed.
  - A flash disk of 4 GB memory space
  - A handheld GPS (Garmin 60Cxs)

• **Software**
  - ArcGIS 10.1
  - Global Mapper v11
  - QGIS 2.0.1
  - Microsoft Office 2007 suite
# Data and their Sources

<table>
<thead>
<tr>
<th>DATASETS</th>
<th>DATA SOURCE</th>
<th>CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital maps of Nairobi</td>
<td>Survey of Kenya</td>
<td>Scale 1:2500</td>
</tr>
<tr>
<td>Open street maps</td>
<td>Open street maps website</td>
<td>Vector data</td>
</tr>
<tr>
<td>Coordinates of collection points and illegal dumpsites</td>
<td>Field work using handheld GPS</td>
<td>Coordinates in UTM projection, WGS1984 datum</td>
</tr>
<tr>
<td>Data on litter bins, sweepers, supervisors, road lengths, market-, park-, parking areas</td>
<td>Department of Environment, City Council of Nairobi</td>
<td>Tabulated data in soft copy form</td>
</tr>
</tbody>
</table>
Overview of Methodology

1. Data identification
2. Data collection
3. Data preparation and verification
4. Is data correct?
   - Yes: Database creation
   - No: Non-spatial datasets

5. Data analysis
6. Results and discussion
Results and Analysis

Geodatabase

- solidwastecollection.gdb
  - area_of_study
    - Nairobi_CBD
    - zone_Boundary
    - Zones
  - collection_points
    - collection_points
  - illegal_dumpsites
    - illegal_dumpsite
  - reclassified_datasets
    - euclidean_distances
    - illegal_dumpsites
    - litter_bins
    - road_lengths
    - total_area_swept
  - river
    - nairobi_river
    - river_buffer
  - roads
    - road_buffer
    - roads
Spatial distribution of Collection points and illegal dumpsites
Thiessen Polygons
Suitability Analysis

Criteria

• Distribution of litter bins
• Distribution of illegal dumpsites
• Euclidean distances from the existing collection points
• Total area swept
• Total roads length
Suitability Analysis Process

• Definition of the problem
• Breaking the problem into sub-models
• Determination of significant layers
• Reclassification/transformation
• Weighting
• Weighted overlay
• Analysis
Reclassified Euclidean Distances
Reclassified Percentage Total Area
Reclassified Distribution of Litter Bins
Reclassified Illegal Dumpsites Distribution
Reclassified Percentage Road Lengths
# Weighted Overlay

<table>
<thead>
<tr>
<th>Factor</th>
<th>Percentage Influence</th>
<th>Ratio of Influence</th>
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<tbody>
<tr>
<td>Distance to the existing collection point</td>
<td>33%</td>
<td>0.33</td>
</tr>
<tr>
<td>Litter bins distribution</td>
<td>27%</td>
<td>0.27</td>
</tr>
<tr>
<td>Distribution of illegal dumpsites</td>
<td>20%</td>
<td>0.20</td>
</tr>
<tr>
<td>Total areas</td>
<td>13%</td>
<td>0.13</td>
</tr>
<tr>
<td>Road lengths</td>
<td>7%</td>
<td>0.07</td>
</tr>
</tbody>
</table>
Suitability Map
Collection Points and Buffers
Conclusion

• A digital map showing the spatial location and distribution of collection points was drawn.
• The illegal dumpsites were mapped for visualization purposes
• A map showing distances from the collection points was obtained from distance analysis.
• Successful suitability analysis carried out in this study led to the determination of suitability of various sites for collection points location.
• Road and river buffers maps were also made.
• This study demonstrates how powerful GIS is in spatial- and non-spatial database integration, management and analysis to identify trends and problems and making appropriate decisions.
Recommendations

• The number of collection points should be increased, and located in the suitable places proposed in this study.
• The identified illegal dumpsites should be eliminated if effectiveness in solid waste collection is to be realized.
• GIS should be adopted in solid waste collection management.
THANK YOU