

Determining Waste Bins Locations by Using GIS

Fatih TERZI, Volkan YILDIRIM, Bura Adem ATASOY, Turkey

Key words: geographical information systems; waste management; waste bins locations

SUMMARY

Increasing world population, urbanization and so on. reasons have led to a significant increase in waste production. This situation has made the process of accumulating waste in trash cans one of the important problems of today's cities. In most cases, placing the bins without the use of any criteria causes waste bins to not be placed effectively. This often causes waste bins to overflow or not to fill completely within certain collection periods. With this study, the location of waste bins have determined by using GIS. In addition, the average of the points was taken when determining the location of waste bins. In this way, waste bins are placed in the most appropriate locations, overflow, etc. environmental problems are minimized. In addition, the cost of the collection process is reduced by preventing waste cans from being empty at the end of the collection period.

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1. INTRODUCTION

Solid waste has been produced since the existence of humanity. Increasing population, urbanization, etc. reasons also increase waste production. This situation has become one of the most important problems of today's cities. (Gutberlet, 2003; Balaban and Baki, 2010; Purkayastha et al., 2015). The fact that the world population continues to increase significantly shows that Solid Waste Management will emerge as a more important concept in the future. The burden of Solid Waste Management on the city in terms of environmental, sociological and financial aspects is very clear. Solid Waste Management consists of many processes or stages such as collection, separation, transfer, recovery, recycling, storage, compost and incineration (Yılmaz and Bozkurt, 2010). In addition, Solid Waste Management can be expressed in three main stages: basically accumulating the wastes at one point, then collecting them from this point and transferring them to the transfer stations and transferring them to the disposal facilities.

Waste collection and transfer operations constitute an important part of the solid waste management cost (Rada et al., 2013; Tavares et al., 2009; Boskovic and Jovicic, 2015). For this reason, it is important for solid waste management to determine the appropriate locations for the waste bins. Placing waste bins anomalously or manually causes environmental and sociological problems. It is also known that this has an impact on cost. For this reason, the most suitable locations for waste bins should be determined with more advanced methods. Geographical Information Systems (GIS) provides great convenience to the decision maker at this point. GIS allows the decision maker to make faster and more accurate decisions by analyzing dense data sets (Yomralıoğlu, 2009).

Location-Allocation models are one of the most used methods for placing waste bins. Some studies use the p-median model. This model reduces the distance and cost of the facility from the source as it averages the location of more than one point (Hillsman, 1984; Aremu et al., 2011).

This study focuses on placing trash bins in optimal locations using GIS. Both population density and walking distance are taken into account while doing this. In this way, it is aimed to improve waste management in terms of environmental and sociological.

2. STUDY AREA

Beşirli neighborhood located in the central district of Trabzon province was chosen as the study area. The area is located at 39° east longitude and 41° north latitude.

The main reason for choosing the study area is that although the buildings are more compact near the sea, they become dispersed as they move away from the sea. Thus, each situation can be examined within the same area.

Road and building data of the study area were obtained via satellite images. Population data were collected by studies in the field. The population living in the study area is 21382.



Figure 1. Study Area

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There are currently 176 waste bins in the study area. These waste bins are placed in manually designated locations. The used waste bin is 770 lt. No other waste bin is used. However, there are areas reserved for collecting waste even though there is no waste bin in some places. The collection vehicle can take the garbage from these areas with the help of staff.

An average of 9727 kg of waste is collected from the area on a daily basis. Wastes are collected without being subjected to pre-separation and taken to the transfer station. The wastes collected here are then transferred to disposal facilities.

3. METHOD

The study consists of three main stages. In the first stage, the criteria to be considered during the placement of the waste bins were determined by literature research. In the second stage, by considering these criteria and using GIS, the most suitable locations for the waste bins were determined. The number of waste bins to be placed in the locations determined in the third stage has been determined by considering the population density.

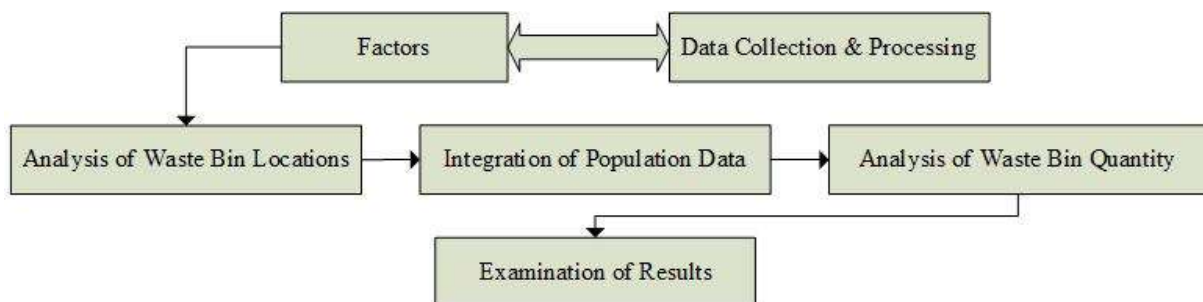


Figure 2. Application stages of the study

Determining the most suitable locations for waste bins is a process that requires multiple criteria to be evaluated together. Within the scope of this study, the factors to be used in the analysis were determined as a result of the interviews with the municipal authorities and citizens. The criteria considered in this study can be listed as follows:

- Walking Distance
- Waste Bin Quantity
- Waste Bin Volume
- Population Density

In order to place waste bins, the number of people living in buildings is integrated into each building in the database. Then, the amount of waste produced on a building was determined by multiplying the average daily waste generation amount per person with number of people living in buildings. Later, buildings falling into every 150 m section of the road were grouped. The weighted center of gravity of these buildings was taken and the location where the waste bin would be placed for that building group was determined. The total amount of waste produced

by this building group was divided by the capacity of the waste bin, and the total amount of waste bin to be placed was obtained.

The weighted center of gravity of the grouped buildings is determined by the formula:

$$X_W = \sum_{n=1}^n \left(\frac{W_i \times X_i}{n} \right) \dots \dots \dots (1)$$

$$Y_W = \sum_{n=1}^n \left(\frac{W_i \times Y_i}{n} \right) \dots \dots \dots (2)$$

W_i in the formula is the weight of the object i and it expresses the total amount of waste produced by the related object.

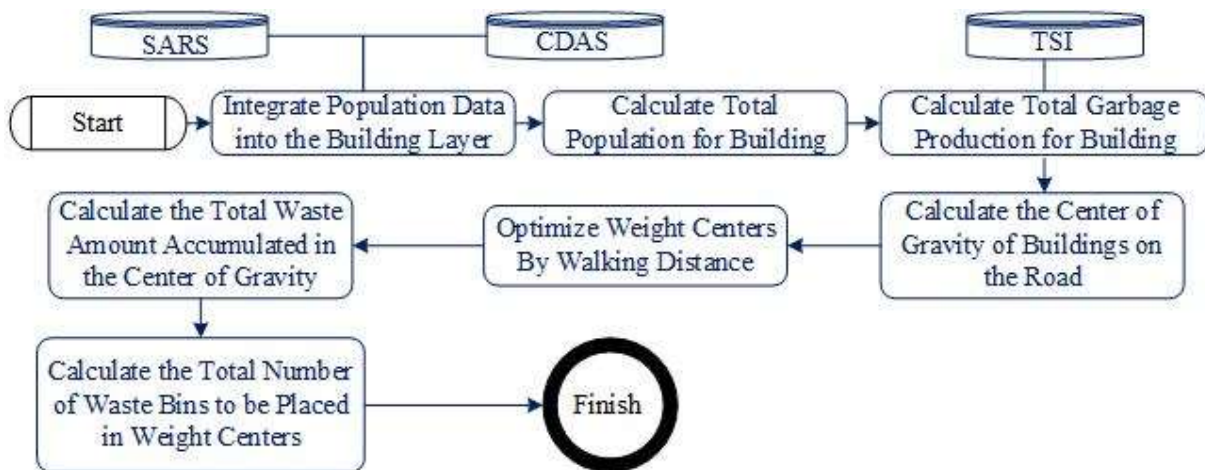


Figure 3. The model used to determine waste bin locations

4. RESULTS

While determining the most suitable locations for waste bins, the average amount of garbage production per capita was obtained from Turkish Statistical Institute (TSI) and this value is 0.79 kg. Only one type of waste bin was used in the analysis. The size of the used waste bin is 770 lt. During the analysis, the views of the local government and the residents were also taken into consideration.

Based on the determined criteria and using GIS, the most suitable waste bins locations were determined. As a result of the analysis, 115 waste bins locations were determined in total and 159 waste bins were placed in total.

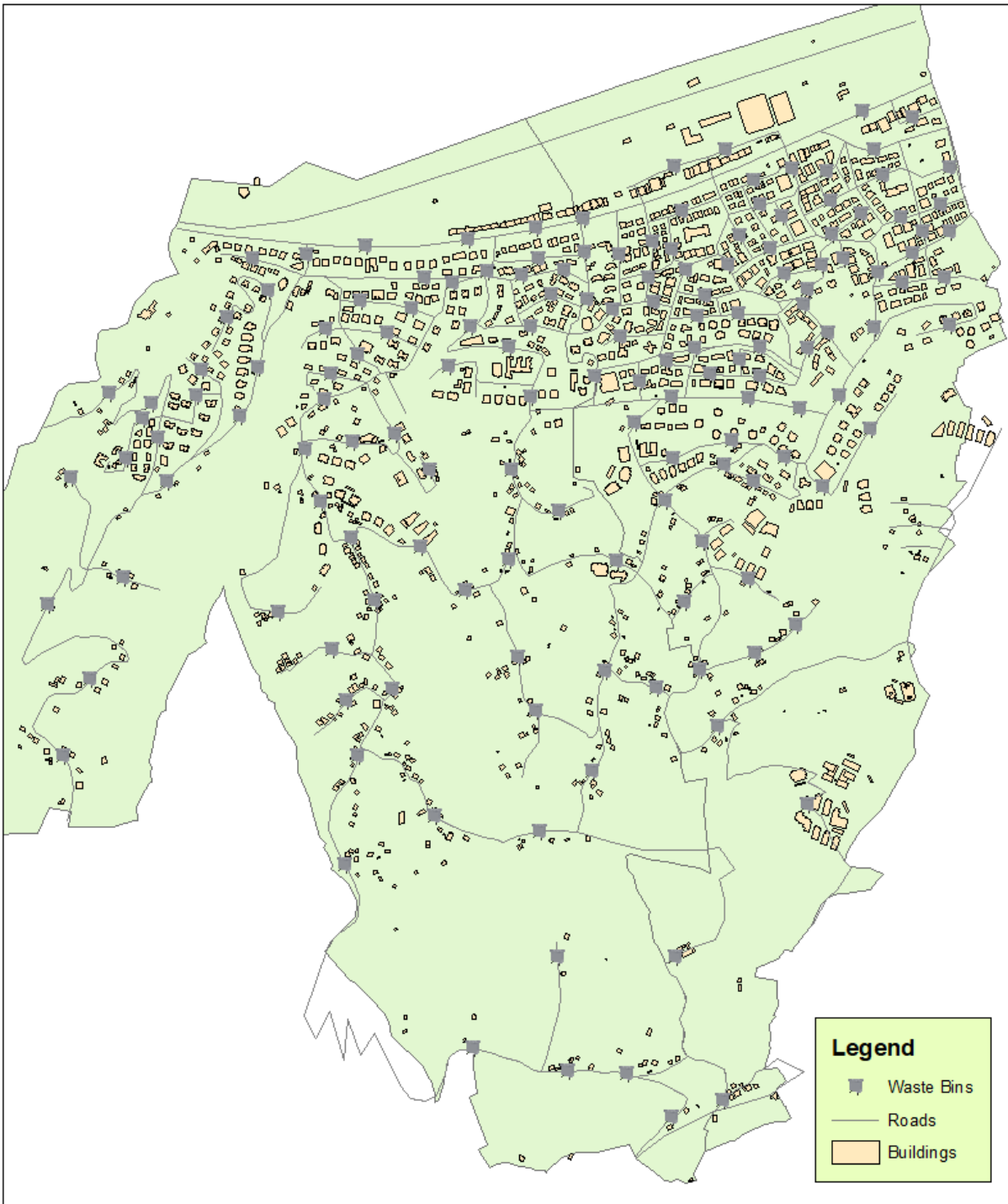


Figure 4. Optimal waste bin locations

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5. DISCUSSION AND CONCLUSIONS

Waste management is a complex process that requires effective decision making and requires the evaluation of many parameters together. GIS, on the other hand, is a tool that allows to perform such a complex process in the easiest and most accurate way by evaluating many parameters together. The success of GIS in this regard has also been demonstrated through studies.

With the studies carried out using GIS, it is seen that the waste management costs are reduced by up to 20% especially in developed countries where infrastructure systems are located. In addition, when it is considered environmentally, the locations determined for waste bins give much better results in terms of the environment compared to the existing locations.

The use of web technologies in the fast and effective management of complex processes such as waste management system is new, but it is the healthiest method. The ability of all stakeholders to perform different operations simultaneously, view the results obtained, make changes and perform new analyzes through a single interface minimizes decision-making time in complex processes. Thus, it is prevented to go beyond the planned with the system.

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BIOGRAPHICAL NOTES

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