

The Impact of security precautions on Municipal Solid Waste (MSW) collection in Baghdad sections

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ABSTRACT

In this study ,spatial video camera was used to capture field data required to establish a geospatial data base that was used with ArcGIS Network analyst for the development of a methodology for the optimization of MSW collection in limited area that have barriers enclosing some roads as a precaution procedure. The method uses various geographical data (road network, location of waste bins, and location of barriers), to measure the difference in time traveled by collecting vehicles. The Results indicate that the presence of barriers increasing the distance traveled by collecting vehicles (23%) in comparison with no barrier scenario each time .With the collecting interval twice a week, this means that a saving of two trips each month if the barriers removed. The study demonstrated the value of spatial videos and GIS as decision making tools.

Further work should focuses on wider areas and also the path from collected areas to sanitary landfills or any other last destination for the wastes and quantify the fuel consumption , gases resulted and total cost differences resulted from the security precaution procedures .

Keywords: MSW, GIS, Spatial videos, ArcGIS Network Analyst, Barriers.

تأثير الأحتياطات الأمنية على جمع المخلفات الصلبة في أحياء بغداد

الخلاصة

في هذه الدراسة ، تم استخدام الفيديووات المكانية لتسجيل البيانات الحقلية اللازمة لبناء قاعدة بيانات جغرافية ستستخدم مع برنامج ArcGIS Network Analyst لتطوير طريقة عمل لأختيار الطريق الأمثل لجمع المخلفات الصلبة البلدية في منطقة معينة فيها مجموعة من الطرق المغلقة بالحواجز كأجراء امني وقائي . تم استخدام مجموعة من البيانات الجغرافية (شبكة الطرق ، مواقع حاويات النفايات ومواقع الحواجز الأمنية) لقياس فروقات الوقت لعربات جمع النفايات . تشير النتائج الى ان وجود الحواجز الأمنية ادى الى زيادة مسافة القيادة اللازمة لجمع النفايات بمقدار (23%) مقارنةً مع عدم وجود هذه الحواجز وهذا يعني ان في حالة ان عملية الجمع تحدث مرتين اسبوعياً ، سيكون هناك توفير مقدار رحلتي جمع شهرياً اذا ما ازيلت الحواجز الأمنية . هذا وقد اكدت الدراسة على اهمية الفيديووات المكانية ونظم المعلومات الجغرافية كأداة اساسية في صنع القرار . في المستقبل ، يجب التركيز على دراسة مناطق اوسع وكذلك دراسة الطريق الرابط ما بين مناطق الجمع ومناطق الطمر او التجميع وقياس مستوى استهلاك الوقود ، الغازات المنبعثة والفرق في الكلف الكلية لعملية الجمع بوجود الحواجز الأمنية .

INTRODUCTION

The Municipal Solid Waste management system consists of several processes, starting with waste generation, collection, transporting, treatment and /or separation and finally disposing.

A proportion of (60-85) % of the total disposal cost is for the collection process, this high percentage is for driver and loading workers' salaries, vehicle purchasing and maintenance, fuel and workers equipment's (Foundation, 2008) , (Athens, 2003).

The optimization of solid waste collection route depend largely on the quality and quantity of information the supports the decision making. Recently, due to both technology maturation and increase of the quantity and complexity of spatial information handled, the Geographic Information System (GIS) was grown rapidly. (Santos, et al., 2008).

Several programs and models that deal with collection of solid waste in urban areas; these models aim to minimize the total cost and/or total driving distance of the collection route (Sonesson , et al., 2012), one of these programs is ArcGIS Network Analyst which has been proved as an efficient technology for analyzing complex spatial applications such as applications, such as urban utilities planning and transportation (Vargues, and Loures, 2008), (Al-Mumaiz, 2012) .

In the island of Santo Antao, Republic of Cape Verde, with the aid of GIS they achieved up to 52% fuel savings even when traveled longer distance (Tavares , et al., 2008). In the city of Trabzon, Turkey a 24.6% reduction in distance and 44.3% in total time travelled with the usage of RouteViewPro™ (Apaydin and Gonullu , 2007).According to Chalkias (Chalkias , and Lasaridi, 2009), reduction in terms of collection time was (17.0%) and travel distance (12.5%) .

In Iraq, the Municipal Waste collection is a complicated process due to several reasons; lack or even absence of scientific and efficient planning and affective procedures to collect and dispose wastes, municipality poor performance , Weak legislation and laws in relation to this aspect, as well as not to impose penalties and fines on violators in order to deter them (Ali, and Abbas, 2012), inadequate waste collection vehicles and the security issue , which lead to make the garbage collector job to be one of the most dangerous jobs in Iraq (Abbood, et al., 2009).

Another effect of the security precautions in Iraq is barriers; these barriers are used to close all the streets on the parameter of a certain area to prevent the entry of cars without inspection at main entrance(s) by security checkpoints, also there are some barriers that used to secure important buildings within the area like Police station, Masjids and others. Some studies in Iraq used the ArcGIS Network Analyst to calculate the optimum routes for transportation purposes, (Al-Mumaiz, 2012) used the ArcGIS Network Analyst to select new highway route In Amarah city –Misan Governorate.

The aim of this study is;

- 1- Develop a methodology for the optimization of the waste collection roots, based on GIS technology route without barriers.
- 2- Indicate the effects of barriers on the municipal waste collection route.

The Study Area and The Existing Collection System

Baghdad has an estimated population of more than 11 million people (Saleh,et al. 2008). Hitten district is in the South Western part of Baghdad (**Figs. 1 and 2**). This paper focuses on section 622 of the Hitten district, an administrative division smaller

than a district. It was built in the late 1960s and initially contained 682 houses. The area is serviced with residential connections to piped water, sewer systems, electricity and phone lines.

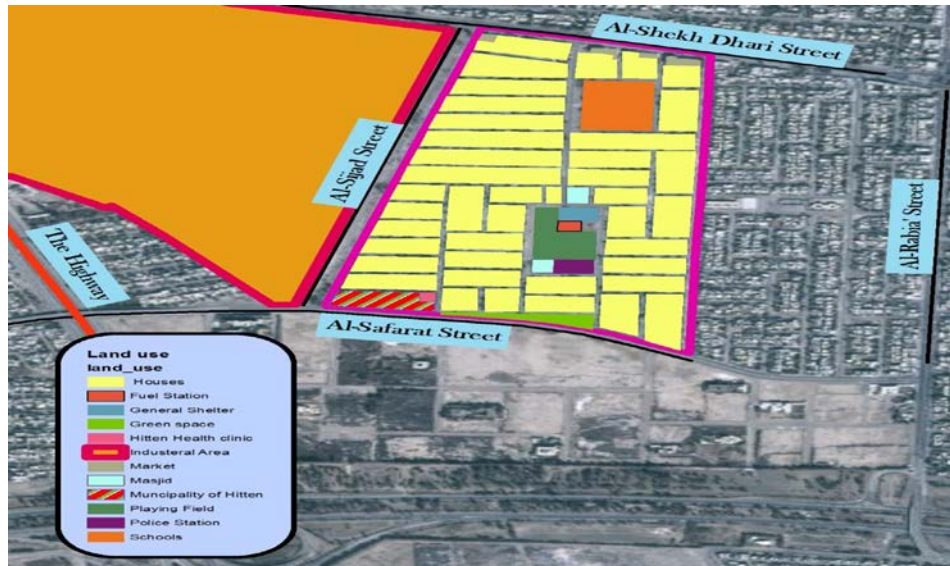
This section (neighborhood) was considered during the period 1970s until the late 1990s to be wealthy and full of large houses (an average size of approximately 600 Sq. Meter). The section also had from the full range of education access, from kindergarten to high schools, and generally good infrastructure including roads and commercial areas.



Figure (1) The location of Hitten district in Baghdad .

Regarding the waste collection situation, twice a week ,a team of two 15 Cubic meter compaction trucks with crew consist of a driver that never leaves the truck and two workers who moves and unloading the bins with door to door service in the section.

The current route for each truck and collecting time interval is irregular and changing all the time because of security situation, lack of monitoring and legislations, different assignments and even personal factors.



Figure(2). Land use of Section 622 in Hitten district.

Methodology

The methodology used in this work to accomplish its goal consists of;

- 1- Data collection
- 2- Geo-Database establishment
- 3- The current optimal route and barriers free optimal route calculated and
- 4- Comparison in time and distance traveled between the two routes.

Data Collection

In this study, a Contour + HD spatial video camera was used to collect the data. Spatial cameras are encoding the spatial location with the collected videos. By this way, more realistic data about the waste bins and security barriers locations are collected. One camera was attached to the driver's window, with a sole camera; each road had to be driven twice to capture both sides. The main advantages of using spatial camera are

- 1- Reducing field equipment's, time and efforts, since the camera has a built-in GPS there was no need to manually locate each bin or barrier.
- 2- Locating houses that cannot be recognized from satellite images especially if they were sharing one roof.
- 3- Collected videos can easily display and digitized on ArcGIS. (Curtis , and Fagan, 2013)

Figures 3 and 4 are showing the captured data by the spatial camera.

Geo database establishments

The geo data base was consists of location of solid waste bins, barriers and the streets. Locations of the bins and barriers were extracted from the spatial videos. Each house was considered to have one bin. Figure 5 shows the area network with the locations of barriers.

The streets were digitized on ArcGIS base Imagery.

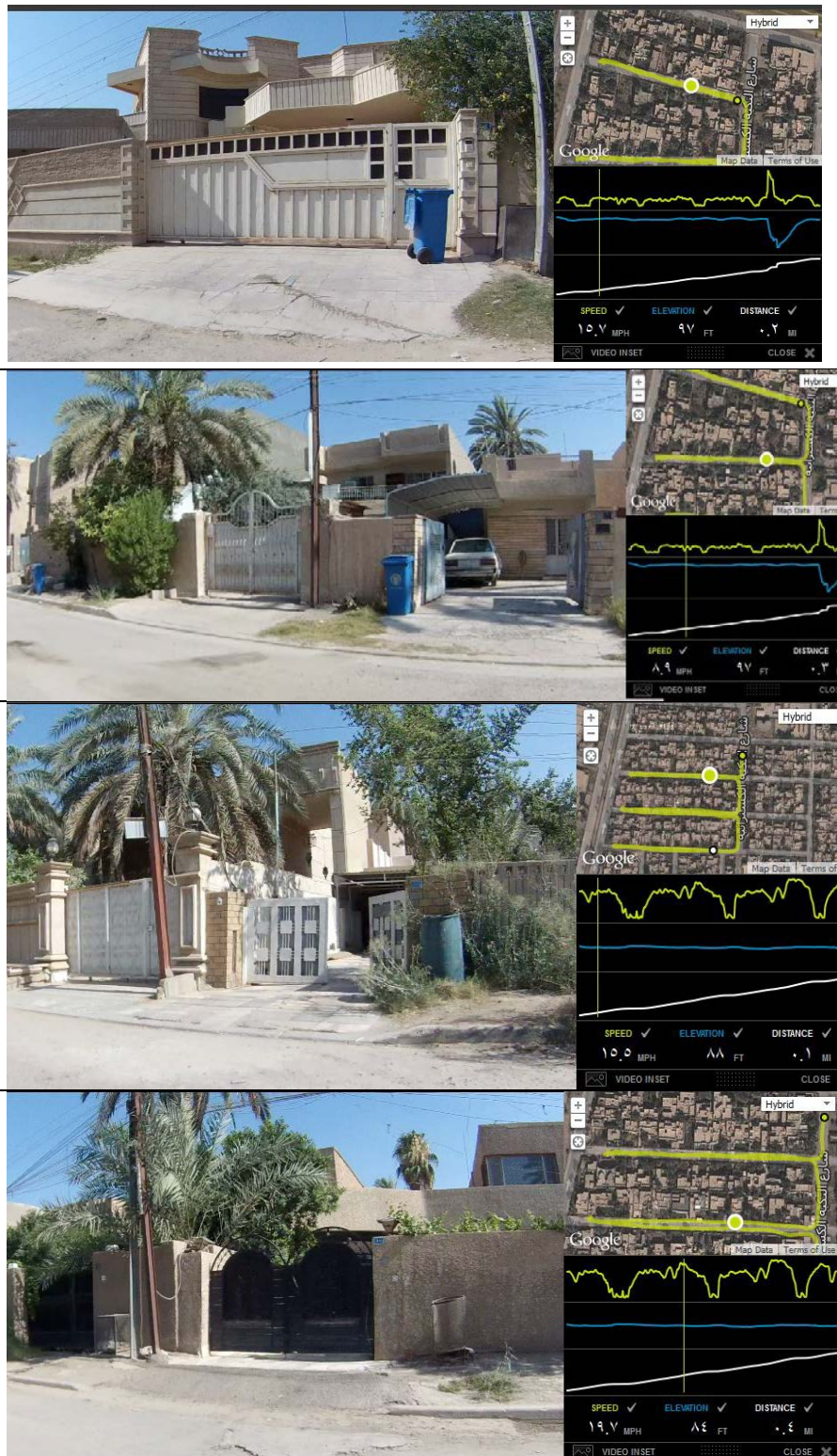


Figure (3). The location of houses and waste bins captured by Spatial Camera.





Figure (4). Location of barriers captured by spatial camera . The current optimal route and Barriers

free optimal route calculated

Transferring digitized streets to the collection routes were created by ArcGIS Network analyst, this extension is used to find minimum distance required to serve certain area (Ghose, et al ., 2006) . Dijkstra algorithm is the algorithm used by ArcGIS Network analyst to find a route through the set of stops with minimum cost (Karadimas,et al ., 2007).

In order to calculate the optimum paths, some variables must be set first ; since the neighborhood is flat and not a commercial area, no elevation or traffic jams were taken into consideration ,the total bins in both cases are the same , which means the delay time resulting from bins pickup was not in consideration as well. The comparison will be made on the total distance traveled by the vehicles with barriers scenario and without barriers scenario.

Figure (5). The area network with the locations of barriers

Comparison in time and distance traveled between the two scenarios

The comparison between the two scenarios will be in time and distance manners. The total distance will be measured directly by the ArcGIS Network Analyst, while the time will be calculated according to different speed limits 10, 15, and 20 Km per hour.

Results

Figure 6 shows the Optimum route for collecting municipal solid waste with barriers scenario.

The total length traveled by collecting vehicle is 19172.5 meter or 19.17 Km, while the optimum route for collecting municipal solid waste without barriers scenario was 14783.67 meter or 14.78 Km as showed in figure 7. This means a reduction of 4.39 Km (23%) in distance traveled by collecting vehicle in No barriers scenario. Table 1 displays the Comparative results of the different waste collection scenarios.

Table (1). Comparative results of the different waste collection scenarios

Scenarios	With barriers	Without Barriers
Distance traveled	19.17 Km	14.78 Km
No. of bins served	883	883
Time traveled with 10Km\h Speed	1.917 hour	1.478 hour
Time traveled with 15Km\h Speed	1.278 hour	0.985 hour
Time traveled with 20Km\h Speed	0.959 hour	0.739 hour

Figures 8 and 9 show the sequence of bin picking in the upper section of the neighborhood with and without barriers respectively, the blue circle represent a bin and the number inside it represent the order of picking. In figure 8 (with barrier), the first bin to be collected is at the upper left corner and the direction of movement is to collect the bins at the outer perimeter of the neighborhood then to collect the bins inside; while in figure 9 (without barrier), the first bin to be collected is at the upper right corner and the direction of movement is entering the neighborhood and to collect around the blocks.

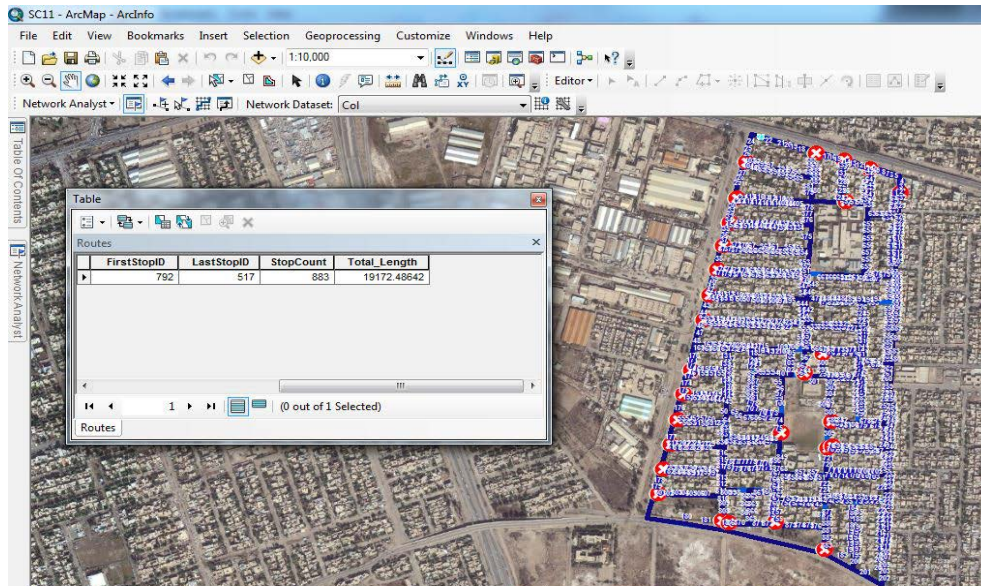


Figure (6).Optimum Route with Barriers scenario

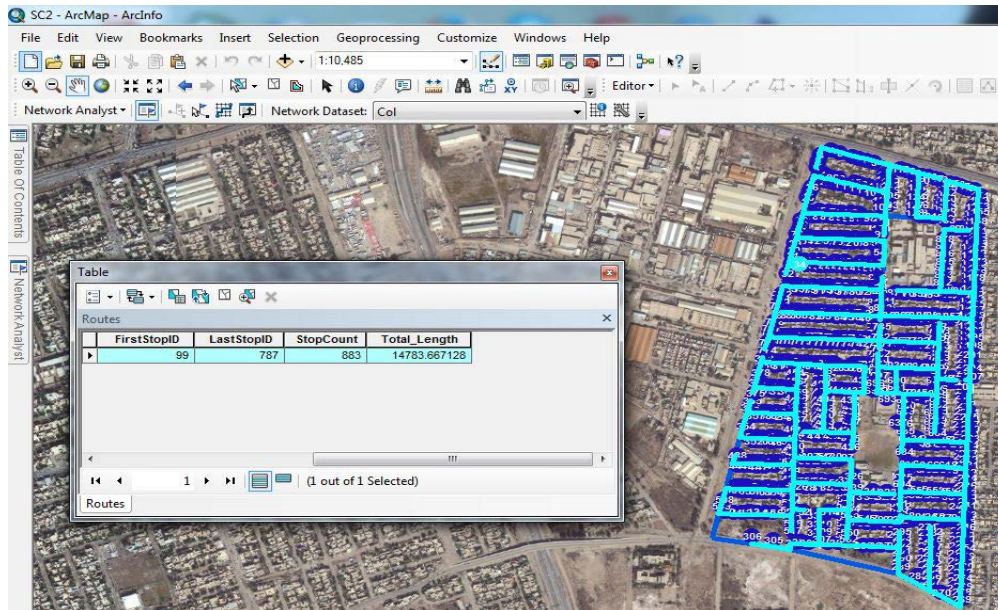


Figure (7).Optimum Route with no Barriers scenario



Figure (8).Direction of movement with Barriers scenario



Figure (9).Direction of movement without Barriers scenario

CONCLUSION

In this study Spatial video Camera was used to capture field data required to establish a geospatial database, used with ArcGIS Network analyst for the development of a methodology of the optimization of MSW collection in limited area ,that have barriers enclosing some roads as security precaution procedure. The Results indicate that the presence of barriers increasing the distance traveled by collecting vehicles by (23%) in comparison with no barrier scenario each time .with the collecting interval of twice a week, this means that a saving of two trips each month if the barriers removed .

Further work should focuses on wider areas and also the path from collected areas to sanitary landfills or any other last destination for the wastes and quantify the fuel consumption , gases resulted and total cost differences resulted from the security precaution procedures .

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