Journal of Applied Sciences Research, 7(12): 1961-1964, 2011
ISSN 1819-544X
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# ORIGINAL ARTICLES

## Solid Waste Truck Monitoring and Management using RFID, GIS and GSM

**[1]M.A. Hannan, [1]Maher Arebey, [1]Huda Abdullah, [2]R.A. Begum and [3]Hassan Basri**

[1]*Department of Electrical, Electronics and System.*
[2]*Institute of Environment and development.*
[3]*Department of Civil and Structural Engineering,Universiti Kebangsaan Malaysia, Malaysia.*

**ABSTRACT**

This paper deals with solid waste monitoring and management system, the integration of communication technologies such as RFID, GPS, GSM and GIS for truck monitoring system In proposed system, truck database has been developed in the way that information of truck ID, driver ID, date and time of waste collection, etc are complied and stored for monitoring and management activities. The proposed system would be able to monitor the solid waste collection process and management the overall collection process. It would provide in time solid waste collection, tracking the vehicle position through the GIS database and also overcome the disadvantages such as usage of minimum route, low fuel cost, clean environment and available vehicle. The technologies that would be used in the proposed system are good enough to ensure the practical and perfect for solid waste collection process monitoring and management for green environment.

***Key words:*** Solid waste truck monitoring, management, RFID, GIS, GSM.

### Introduction

Generally, the solid waste is defined from households refusal and non-hazardous solid waste is from industrial, commercial and institutional establishments such as hospitals, market waste, yard waste and street sweepings (GAIA, 2003). Today, Solid waste management has changed a long way from the old days when garbage was collected by horse and disposed outside of town. Today, it is almost hard to manage waste collection process and management without high technology to pinpoint the locations of vehicles and recycling bins (Lau, 2004). In the developing countries, waste management is becoming an acute problem as urbanization and economic development increase leading to larger quantities of waste materials (Fadel, 2006). In Malaysia, the waste generation is increasing tremendously due to its developing activities and it has an accompanying problem with the disposal of this waste (Marts, 2009). The amount of solid waste generated in Malaysia is steadily increasing and the government is currently focusing on methods to approach the challenge. Table 1 show the solid waste generated (WG) in major urban area in Malaysia from 1970 until 1990 (MHLG, 1999).

Due to growing population and increasing consumption, the amount of solid waste generated in Peninsular Malaysia went up from 16,200 tons per day in 2001 to 19,100 tons in 2005, an average of 0.8 kilogram per capita per day. In Kuala Lumpur waste generation is about 3,000 tons a day and forecasts show that this will increase further in coming years (Hassan *et al.*, 2000). To overcome the growing waste, it needs an efficient and robust system that can improve and reduce the time as well as the cost of the solid waste management (Hassan *et al.*, 2001). The proposed system for the solid waste monitoring and management would be in time, low operational cost and environmental friendly.

**Table 1:** Solid WG in major urban area in Malaysia.

| Urban area | 1970: WG tones/day | 1980: WG tones/day | 1990: WG tones/day |
|---|---|---|---|
| Kuala Lumpur | 98.8 | 310.5 | 586.8 |
| Johor Bahru | 41.2 | 99.6 | 174.8 |
| Ipoh | 22.5 | 82.7 | 162.2 |
| George town | 53.4 | 83.0 | 137.2 |
| Klang | 18.0 | 65.0 | 122.8 |
| K. Terengganu | 8.7 | 61.8 | 121.0 |
| Kota Bharu | 9.1 | 56.5 | 102.9 |
| Kuantan | 7.1 | 45.2 | 85.3 |
| Seremban | 13.4 | 45.1 | 85.2 |
| Melaka | 14.4 | 29.9 | 46.8 |

**Corresponding Author:** M.A. Hannan, Department of Electrical, Electronics and Systems, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Malaysia.
E-mail: hannan@eng.ukm.my

*J. Appl. Sci. Res., 7(12): 1961-1964, 2011*

*Problem Overview:*

The main problems of the existing solid waste collection process and management system are as follows (Ping and Yang, 2008; Chandravathani, 2006; Alam Flora, 2009).

1. Lack of the information about the collecting time and area.
2. Lack of the proper system for monitoring, tracking the trucks and trash bins that have been collected in real time.
3. Loss of productivity due to inefficient utilization and unauthorized use of vehicles.
4. There is no quick response to urgent cases like truck accident, breakdown, longtime idling.
5. There is no quick way to response to client's complaints about uncollected waste.

However, with the conventional system, it is impossible to get all the facilities in time. Because, it may need some trucks to be available for important special events, some are to be on a daily schedule and some trucks may be under maintenance. To stimulate all these facilities, an effective and robust system is needed. The proposed system would be able to solve the mentioned problems with robust solution.

*Conceptual Framework:*

Solid waste collection minimization and improving its efficiency includes the costs per km and per hour to transfer the waste after collection from the various facility locations. There are some factors that affect collection productivity and efficiency (MLGPC, 2008) such as follows.

1) Service level: collection point, frequency and waste material
2) Route related: containers, distance, constraints, topography, delays and road conditions.
3) Collection methodology and climate related: crew size, collection procedure, wind and rain.

Based on the review, the developed conceptual framework for solid waste collection process, cost minimization and management can be seen in Figure 1.

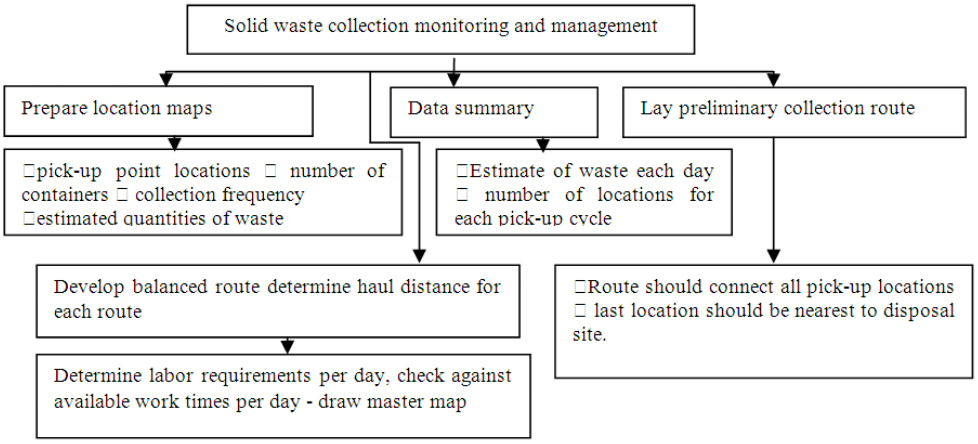


**Fig. 1:** Conceptual framework for solid waste minimization.

*System Architecture:*

The structure of the proposed system is developed using RFID, GIS and GSM for solution existing problems and streamline solid waste monitoring and management efficiencies (Maher Arebey, 2010, M.A. Hannan, 2010). In this system, there is a great deal of process intelligence that would ensure the system capability and also justify its validity. This is not only in time-related factors such as time spent to, from and at locations, but more importantly, the accurate tracking of a solid waste bin's serial number and location. These elements are important to ensure the proper collection and management of waste.

The solid waste management tracking system addresses the above constraints to provide a solution. The proposed system is a web-based solution. Solid waste management clients will be able to view and retrieve trucks and their trash bins information via a web-based. The architecture is client-server architecture where the web browser is the client. GSM and GIS are chosen for the communication between the tracking unit and the server and vehicle position tracking. It is also ideally suitable for data transfer over an always on-line connection between the control station and trucks. The location information collected through the GPS in real time and

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would be stored in a central database in which all client would be able to acess this information via web-base management system. Figure 2 shows the architecture of the system.

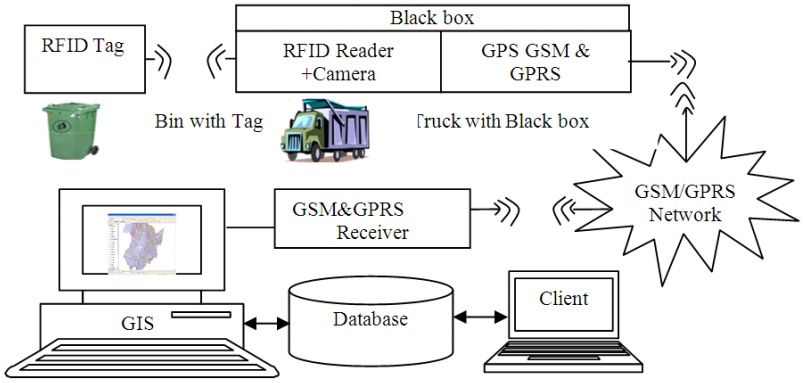
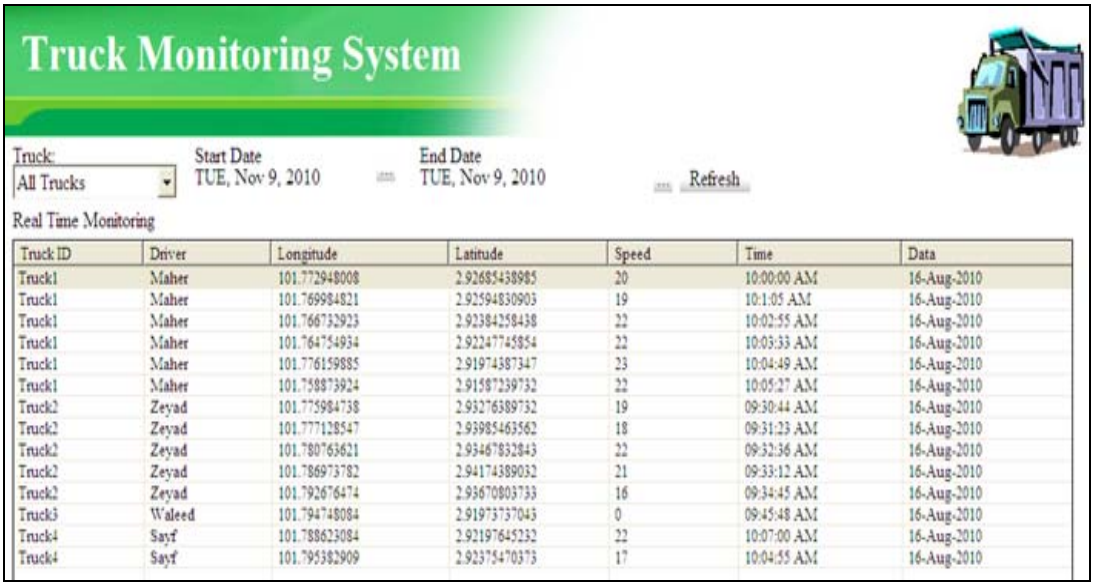



**Fig. 2:** Architecture of solid waste monitoring and management system.

**Results and Discussion**

In this section, the database for monitoring the collection process is discussed. The information such as bin ID, date of waste collection and truck ID, stored in the RFID tag were read by the RFID reader. The latitude and longitude coordinates of bin location were provided by GPS module that attached in the truck along with RFID reader and GSM module. All these information are combined together and sent to the control station via GSM transceiver. The control station compiled all the information and stored in the system database as shown in Figure 3.




| Truck ID | Driver | Longitude | Latitude | Speed | Time | Data |
|---|---|---|---|---|---|---|
| Truck1 | Maher | 101.772948008 | 2.92685438985 | 20 | 10:00:00 AM | 16-Aug-2010 |
| Truck1 | Maher | 101.769984821 | 2.92594830903 | 19 | 10:1:05 AM | 16-Aug-2010 |
| Truck1 | Maher | 101.766732923 | 2.92384258438 | 22 | 10:02:55 AM | 16-Aug-2010 |
| Truck1 | Maher | 101.764754934 | 2.92247745854 | 22 | 10:03:33 AM | 16-Aug-2010 |
| Truck1 | Maher | 101.776159885 | 2.91974387347 | 23 | 10:04:49 AM | 16-Aug-2010 |
| Truck1 | Maher | 101.758873924 | 2.91587239732 | 22 | 10:05:27 AM | 16-Aug-2010 |
| Truck2 | Zeyad | 101.775984738 | 2.93276389732 | 19 | 09:30:44 AM | 16-Aug-2010 |
| Truck2 | Zeyad | 101.777128547 | 2.93985463562 | 18 | 09:31:23 AM | 16-Aug-2010 |
| Truck2 | Zeyad | 101.780763621 | 2.93467832843 | 22 | 09:32:36 AM | 16-Aug-2010 |
| Truck2 | Zeyad | 101.786973782 | 2.94174389032 | 21 | 09:33:12 AM | 16-Aug-2010 |
| Truck2 | Zeyad | 101.792676474 | 2.93670803733 | 16 | 09:34:45 AM | 16-Aug-2010 |
| Truck3 | Waleed | 101.794748084 | 2.91973737043 | 0 | 09:45:48 AM | 16-Aug-2010 |
| Truck4 | Sayf | 101.788623084 | 2.92197645232 | 22 | 10:07:00 AM | 16-Aug-2010 |
| Truck4 | Sayf | 101.795382909 | 2.92375470373 | 17 | 10:04:55 AM | 16-Aug-2010 |

**Fig. 3:** Solid waste truck information in the database.

All information such as truck ID, driver name, longitude, latitude, truck speed, collection and date were received in the control station via GSM and GPRS transceiver and complied in the system database. When all this information compiled together, the operator will be able to monitor the whole collection process. All these data is stored in the database and will be used for future planning.

*Conclusion:*

In this paper, a new method of solid waste monitoring has been proposed, the methods integrates communication technology to improve the solid waste collection efficiency. The implementation of the system

with graphical user interface is contributed to provide data about the trucks and enhance the collection process. This proposed system would not only function for collecting and updating data automatically and timely, but also it could analyze and use data intelligently. The proposed system would solve a lot of problem related to solid waste collection, monitoring, minimizing cost and accelerate the management.

**Acknowledgement**

The authors are acknowledged this work for the financial support under the grant UKM-PTS-0017-2009.

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